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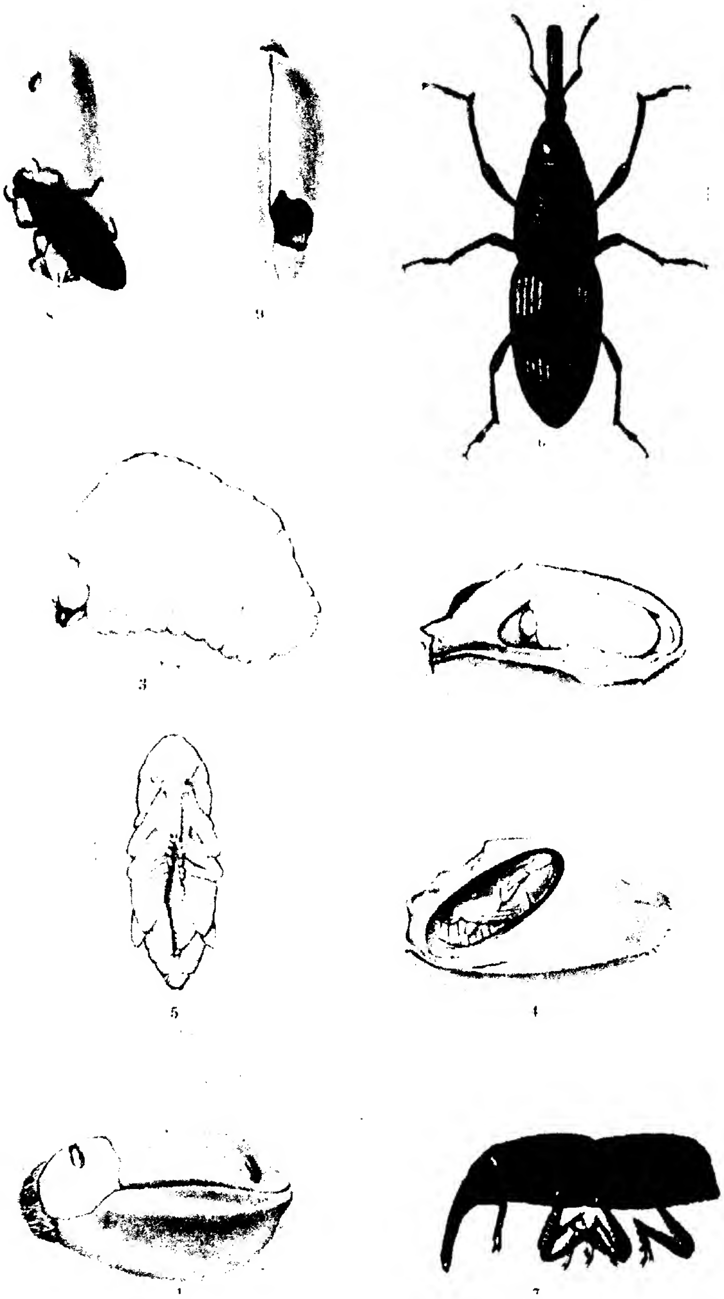

EXPLANATION OF PLATE.

THE RICE WEEVIL (CALANDRA ORYZÆ).

Fig	1	Eggs laid on and in a Wheat-grain. x 8.
,,	2	Larva feeding inside a grain. x 8.
,,	3.	Larva removed from grain. x 16.
,,	4.	Pupa in natural position inside grain. x 8.
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WEEVIL AND DRY WHEAT.

By T. BAINBRIGGE FLETCHER, R.N., F.E.S., F.Z.S.,

Offg. Imperial Entomologist.

Introductory.

An insect that does an immense amount of harm in India is the common Rice Weevil (*Calandra oryzæ*), found not only in wheat but in *juar*, maize, rice and, indeed, in all stored cereals and peas, though best known in rice. Owing to its minute size it is easily overlooked until its numbers have increased to an extent which makes the aggregate loss very large, small though the individual damage may be. Its small size may best be realised from a consideration of the fact that its life-history is accomplished inside a single grain, which furnishes it at the same time with food and shelter. As in the case of most destructive insects, however—locusts may be taken as an exception—the amount of damage done is inversely proportional to the size of the insect.

Not only does the Rice Weevil attack cereals in the grain, but it will also feed on them when ground, and (in India at least) this little beetle is one of the principal offenders in the case of a bag of flour being found "weevilly" when opened. It is only fair to add, however, that this weevil is not responsible for the repulsive taste communicated to the flour by other minute beetles (*Tribolium*) often found in the flour also. Rice and wheat in the ear are not, or only very slightly, attacked, but barley in the ear is as much subject to attack as when husked.

In many parts of India endeavours are made to secure grain against insect and other attack by storage in tight receptacles, although these need to be practically air-tight to keep out minute insects such as this; but in some districts, although

the grain is stored in a sort of wattle cage to keep out rats—some time a cat is shut into the cage with the grain to make assurance doubly sure—yet no attention is paid to destructive insects which breed unchecked and devour the cultivators' store none the less surely than the rats. *De minimis non curat agricola* might well be given as the modern version of an old saw.

It is extremely difficult to estimate the actual damage to stored crops done by this weevil. Such must vary to a very large extent according to local conditions. The following experiment, however, carried out in the Pusa Insectary, will give some idea of the harm which may be done. On 27th April 1910 one seer (2lbs.) of unaffected wheat grains was put into a box with a large number of wheat weevils and left: on 1st October 1910 (*i.e.*, after 167 days) the weevils and dust were separated from the wheat-grains, the dust weighing ½ chittak (1 ounce), the wheat-grains only 11 chittaks (1lb. 6oz.) so that roughly one-third of the wheat had been totally destroyed in less than six months. Some twenty years ago a leading firm of grain merchants estimated the annual loss due to these weevils to be 10% in the year. Taking the annual average loss at only half this (5%), the damage done yearly throughout the whole of India must run into lakhs of rupees.

Distribution.

Like nearly all grain pests, the Rice Weevil has been carried all over the world with shipping, and it is very difficult to say where its original home may have been, but we have no reason for believing that it is not indigenous in India. This weevil does not seem to have been known to Linnaeus in 1758, the date of the Tenth Edition of the "Systema Naturae," but was described five years later in the sixth volume of his "Amoenitates Academicae." The Twelfth Edition is not accessible here, but the species is included in the Thirteenth (Gmelin's) Edition (1788-1793) without any further indication of origin than the words, "Habitat in oryza, diutius asservata." We may assume that the species had attained a world-wide distribution before it

was known to Entomologists, and that its original home was probably in the warmer rice-growing districts of Southern and Eastern Asia. It is abundant everywhere in India, Burma and Ceylon, and is known under various vernacular names, some of which are "Chele poka" (Bengal), "Hena poka" (Nuddea), "Sulsi" (Delhi Bazar, Calcutta), "Ghun" and "Keed" (United Provinces), "Sonda-Kida", "Sonda" and "Pore-kida" (Poona), "Keri" (E. Bengal), "Kapra" (Delhi), "Kurrin chottan" (S. Malabar), "Nusi" (Ceded Districts), "Sundawalla poka" (Orissa), and "Sundhiu Killu" (Gujerat).

Life-History.

In colder climates it is said that this beetle has only one* generation in the year, but in the warmer parts of India it is probable that there are about eight broods annually, whilst in districts with an appreciable amount of cold weather there may be only four or five generations in the year.

The length of time occupied in attaining the perfect state during the warmer months varies from about five to nine or more weeks, as is seen in the following table of actual records kept at Pusa during 1910:

Parents put into a jar of Wheat.	Young emerged.	Period in days.
10–12 March.	27–30 April.	49–50.
27–30 April.	15 June.	47–50.
28 ..	20 ..	54.
20–22 June	25 July.	34–36.
8 July.	12 August.	36.
8 ..	15 ..	39.
26 ..	20 ..	38.
22 ..	26 ..	36.

It would naturally be expected that in the hottest month of the year (*i.e.*, May) the life-history would occupy the shortest period, but it is evident from the above table that such is not the case and another factor must be sought for. By plotting the results of the table in the form of a curve and adding

* The statement is attributed to Miss Ormerod, but I have been unable to trace the original reference.

curves for the average mean temperatures for this period of the year, it immediately becomes apparent that the curves do not coincide; but the addition of another curve, that of atmospheric humidity, helps to throw a little light on the subject, and there seems little doubt, but that—at any temperature at which breeding is possible—the period of development of the immature stages varies inversely with the degree of humidity of the air. The practical application of this point will be discussed later on.

Returning now to the life-history of the weevil itself, in its first stage it is a minute egg about ·6 m.m. long and ·25 m.m. broad, cylindrical in shape with perfectly rounded ends and a smooth surface, and of a clear translucent colour. (Frontispiece, fig. 1). The mother-weevil gnaws a small hole almost longitudinally into a wheat grain, usually near the apex which is provided with a covering of minute hairs. The egg is thrust into this hole lengthwise, and sometimes the mouth of the hole is then plastered over with chewed-up dust from the wheat, but sometimes the hole is left open and then the end of the egg is visible almost on a level with the surface of the grain. On splitting open the grain it is extremely difficult to distinguish the egg from the interior, its colour being so similar to that of the starchy substance of the grain itself. In many cases, however, the eggs are simply deposited loosely amongst the grains or stuck to the outer surface of a grain in an exposed position, without any hole having been bored.

The eggs hatch as a rule on the fourth day after they have been laid, when the young larva gnaws a hole in the side of the egg-shell and makes its way out with a sort of peristaltic movement. Except for its smaller size, about ·6 m.m. in length, the young larva resembles the full-grown one in every respect and, like it, assumes a curved position with the back arched upwards (Figs. 2 and 3). On hatching out, the young larva bores into the interior of the grain in or on which the egg was originally laid and consumes the starchy substance of the interior, passing its whole larval and pupal life inside this one grain. When fully grown the larva is about 2·5 m.m. (1/10th inch) in length

when fully stretched out, but it usually remains in a slightly curved position (fig. 3) with the back humped up, and in this state it barely measures 2 m.m. long. It is a thick, fleshy, white, legless grub and, except for its brown or yellow brown head, it has no markings of any sort, but the body is minutely wrinkled transversely. As it never leaves its food supply, it has no need of legs but it can move about by peristaltic motions of its muscles ; for the same reason, no outward sign of damage is shown by the grain whilst the larva is inside it.

The pupa is about 2·5 m.m. (1/10th inch) long, of a very pale yellow colour, after about three days turning to a darker brown. The posterior extremity is bent downwards a little and, as is the case in all ordinary curculionid pupæ, the legs and snout are clearly distinguishable (figs. 4 and 5). The larva pupates inside the grain, in which it has been feeding, in a small chamber cleared by pushing to one side the pellets of frass and flour. No hole is prepared for the emergence of the beetle, which gnaws its own way out. The holes found in affected wheat are thus caused by the weevils which have attained the perfect state, either on their first emergence from the pupa or by their subsequent gnawing of the grains in the process of feeding. The pupal period is about six days in the warm weather.

The weevil itself may live a few weeks or several months, and in the northern parts of India generally passes through the cold weather in a dormant condition. It is a very small dark-brown beetle, about 1/10th inch long, with four orange-coloured spots on top of its body and the usual long down-curved beak characteristic of the weevils. (Figs. 6 and 7).

In the case of most insects the damage which they cause is effected during their larval existence, but the Rice Weevil on the contrary is destructive after it has reached the perfect state by gnawing into grains and feeding on their contents (figs. 8 and 9), and it seems probable that the destruction wrought by the beetle after attaining maturity is greater than that done before it has attained this condition. As the food-supply is constant, there appears to be no regular breeding-season and all

stages of the life-history may be found at any period of the year, although when the temperature is low all vital activities are decreased up to the point of suspension. The mature beetles themselves may also apparently live for a long time, so that members of more than one generation may perhaps be found occurring together. Owing to these two points, it is extremely difficult to say how many generations there may be in a year in any particular locality, but the average is probably about eight for Southern India and about five for the colder regions of the North.

MEANS OF CONTROL.

Had the Rice Weevil no natural enemies, there would be no limit to its increase but the want of food or, in other words, its consumption of our stored cereals would be absolute. Living a life of concealment, as is its habit during its early stages, it would be imagined that at this period of its existence at least it would prove comparatively immune from enemies: happily for man's welfare, however, this is not the case, as during its larval life it is extensively parasitised by a minute coppery-green Hymenopterous (four-winged) fly which has been called *Pteromalus oryzæ* after its host. This tiny fly searches for a grain containing a larva of the weevil and lays an egg in the larva: this egg hatches into a grub which feeds inside the weevil larva without actually killing it till it is itself full-grown, when it attacks the vital portions of its host, kills it, and then changes into a pupa, from which there presently emerges another tiny coppery-green fly ready to pair and (should it be a female) to search for more weevil-larvæ in which to lay its eggs.

Useful though this parasite undoubtedly is, it is obvious that its usefulness must be of limited application, as a parasite which is too successful will soon have its numbers reduced by want of a host on which to feed. We must therefore consider artificial means of control and these fall under two heads, (*a*) *fumigation* and (*b*) *drying the grain*. In considering both of these it must be understood that wheat in grain is especially referred to.

Fumigation.

Fumigation is quite a simple matter if the grain is contained in a receptacle which is, or can be rendered temporarily, more or less air-tight. Carbon Bisulphide, at the rate of about 1½ lbs. to the ton of grain, is the usual fumigant, the liquid being simply poured over the grain or placed in shallow vessels on top of it, and the grain exposed to the fumes for 24 hours. It must be remembered that the fumes of Carbon Bisulphide are an irritant poison if inhaled to any extent, although the smell is calculated to prevent this being done. It is still more important to note that this liquid is inflammable, and that the fumes form an explosive mixture when mixed with air in the presence of fire and that no light or fire (even a lighted pipe or cheroot) must be allowed near when fumigation is going on.*

Fumigation will simply kill all insect life in the grain but will not exert any permanent inhibitory effect, so that the operation should be renewed at least every six weeks. A more permanent deterrent effect is produced by mixing a small proportion of naphthalin with the grain. This is especially useful for keeping small quantities, such as samples for Exhibition purposes. If required for culinary use, the larger lumps of naphthalin may be sieved out and small fragments evaporated out quickly by exposing the grain in a thin layer to the sun and air for a day or two. The germination of the wheat is not affected. In one experiment conducted at Pusa, a boxful of wheat was taken, covered loosely with a sheet of paper on which a layer of flake naphthalin was sprinkled, and left under these conditions between 27th April and 1st October. On this latter date the wheat was found absolutely free from weevil, and two samples tested for germination by actual growing gave results of 82% and 68% respectively. Another box of wheat kept under exactly similar conditions but without the naphthalin, was found to be badly attacked by weevil at the expiration of the same period.

* For furt[illegible] Insect Pests, pp. 258-25[illegible]

DRY WHEAT.

Experiments carried out at Pusa during 1909 appear to indicate that wheat will not be attacked by weevils under certain conditions of dryness. In co-operation with the Imperial Agricultural Chemist various samples of wheat were taken and prepared at different degrees of dryness, and these samples were then tested with living weevils to see how far the weevil was able to live and breed in each.

The experiments, which were all done in triplicate to avoid error as much as possible, were made with similar bottles each containing one pound of wheat dried to a known degree of moisture and forty living adult weevils. The bottles were then closely stoppered, sealed with paraffin wax, so that they were absolutely air-tight, and left undisturbed for six weeks. At the end of this period they were opened, the original forty weevils in each bottle searched for and found, any further weevils noted, and the whole kept under such conditions that any immature individuals would be afforded time to hatch out or that any apparently dead weevils would have an opportunity of reviving.

Two samples of wheat freshly harvested and taken straight from the threshing floor in 1909, were found to contain 6·7 and 7·2 per cent. of moisture respectively. It would appear, however, that these ratios were abnormally low as the following percentages of moisture were found in wheat harvested at Pusa in 1910, care being taken that the samples suffered as little loss as possible from the harvesting until they were secured in bottles :

Mozuffernaggar White	...	...	10·16	Per cent	
Punjab, No. 2	...	...	8·27	"	Average 8·62
" " 4	...	...	8·12	"	
" " 7	...	...	7·99	"	
" " 9	...	...	8·14	"	
" " 12	...	...	7·75	"	
" " 14	...	...	8·09	"	
" " 16	...	...	9·10	"	
" " 17	...	...	8·63	"	
" " 19	...	...	9·39	"	
" " 20	...	...	9·24	"	
" " 22	...	...	8·55	"	
" " 24	...	...	8·69	"	

By ordinary drying of this wheat in the sun after harvesting it was found that the moisture-content could be reduced with ease to about 4 per cent., whilst the same wheat exposed to the open air until July (after the rains had set in) then contained 14·1 per cent., of moisture. By drying or damping this, exact degrees of moisture were of course obtainable.

(*a*) In the experiments made with absolutely dry wheat (0 per cent. moisture) and with wheats at 4·1 per cent., 6·7 per cent. and 7·2 per cent., all the weevils introduced were killed off without breeding at all.

(*b*) In the experiments with wheat containing 8 per cent. moisture, the weevils became inactive after a few days and were apparently killed off without breeding.

(*c*) In the 9 per cent. wheat active breeding did not go on at all: the bottle was opened after six weeks, examined and closed again: after this exposure to fresh air of greater humidity, the weevils became more active and breeding commenced.

(*d*) In the 10 per cent. samples there was rather more activity and a little breeding took place. When opened after six weeks and exposed to a damp air breeding became very active and the immature stages were passed through more rapidly than when kept at 10 per cent. A moisture-content of this value would appear to allow breeding though if the air is unchanged in the confined space of a bottle, this is slow, and it is accelerated when air is allowed free access.

(*e*) The 12 per cent. wheat was a failure from an experimental point of view, no weevils living or breeding at all. On opening the bottle some smell was perceptible, and it may be that some chemical action had occurred. Otherwise, there seems to be no satisfactory reason why the weevils should not have flourished.

(*f*) In the 14 and 16 per cent. samples, there was breeding in some bottles but not in all. It must be remembered that 14 per cent. is the moisture-content of wheat exposed to the open air at the beginning of the rains, when the conditions are at their optimum from the weevils' point of view.

(g) Experiments made with wheat damped to contain 20 and 25 per cent. of moisture were a total failure, the wheat mildewing in all the bottles and the weevils being rapidly killed off.

In estimating the value of the above experiments, it must be remembered that they were made under unnatural conditions distinctly adverse to the well-being of the weevils, which were tightly sealed up in a confined space and cut off from any change of air. Then, again, the weevil is not an easy creature to work with, since its immature stages are passed in concealment, so that it is not easy to see what is going on. Too much reliance, therefore, must not be placed on these experiments, as the confined conditions on a small scale such as this may not give an exact reproduction of what would take place on a larger scale under exposure to the open air. But the above results (experiments (a) and (b)) apparently justify us in saying that wheat which can be got down to a moisture-content of 7 per cent. or less in April-May before being stored should be immune from attacks of weevil and, if it can be stored in insect-proof receptacles, it should remain free from attack, even after the rise of humidity has brought its moisture-content above the critical point. We have seen that wheat can be dried in the sun to about 4 per cent., and this should provide an ample margin of safety. As the experiments were made with Behar wheats presumably an even lower moisture-content would be obtainable with Punjab wheats, as these latter would be drier on coming from the threshing-floor.

Although bottle experiments on a small scale serve little purpose in indicating what may be expected on a large scale, as we have to take into account so many factors, the chief of which is the fact that the weevil is a living animal with its individual likes and dislikes and vitality; yet they serve to indicate roughly the limit of safety, which may itself vary slightly in different varieties of wheat.

To summarise the foregoing :—

(i) Wheat when threshed contains about 8 per cent. of moisture.

(ii) By exposure to the sun in April-May, this may be reduced to about 4 per cent.

(iii) Whilst containing less than 8 per cent., stored wheat is immune from attack by weevil, and any weevils which may obtain access to it are soon killed off.

(iv) If stored in insect-proof receptacles wheat which is already free from weevil will be preserved from attack.

RURAL ECONOMY IN THE BOMBAY-DECCAN—IV.

By G. F. KEATINGE, I.C.S.,

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(*Continued from page 220 of Vol. VI Part III.*)

VII.—Dead Stock.

The implements commonly used by the Deccan cultivator are as follows :—

1. The *Nangar* or plough, of various sizes, cost Rs. 2 to Rs. 10.
2. The *Pabhar* or seed drill, cost Rs. 5.
3. The *Kolar* or harrow, cost Rs. 3-8.
4. The *Kolpa* or bullock hoe, cost Rs. 2.
5. The *Maing* or clod crusher, cost Rs. 4.
6. The cart, cost Rs. 40.

Hand Implements.—

1. The *Kodali*, used as a hoe, pick or spade, 6 annas.
2. The *Khurpe*, a small sickle used for weeding, etc., 2 or 3 annas.
3. The *vila*, or sickle, 6 to 8 annas.

In cases where there is an irrigation well the *mhot* or leather water bag will be required. With pulleys, ropes, etc., its cost may be taken at Rs. 40.

Implements of the kind mentioned above have been in use in the Deccan from time immemorial. They are ingenious, and up to a certain point effective. They are made mainly of wood.

and contain as little iron as possible. They have the merit of being cheap and easily repaired; but they cannot be said to be efficient according to the modern standard.

In India, as elsewhere, the plough is about the most important agricultural implement. As regards ploughing the custom varies greatly in different parts of the Deccan; but in some parts it is customary to plough deep every year: and in all parts the land must be well ploughed for irrigated crops. In the case of black soil which is infested with deep-rooted weeds the only method of cleaning the land is to plough deep; and the heavy black soil of the Deccan presents many difficulties to the cultivator. It is therefore most important that the large plough should be an efficient implement. But anyone who takes the trouble to observe a heavy plough at work must admit that it is a clumsy implement, and that it gives a small result for a large amount of labour applied. Five or six yoke of oxen, with several drivers besides the ploughman, may be seen straining at the task, and making very slow progress. It would be out of place here to enter into the merits or defects of various implements; but it may be said generally that a change is bound to come over Indian implements in the near future and is already beginning. This change will be accomplished here as it has been in other countries by the introduction of a new factor in the case, namely, cheap iron. The change in England dates from the beginning of the 18th century when the improved process of iron and steel production revolutionised agricultural implements, and proved the greatest boon to English agriculture. The change took place later in other countries; and in parts of France the wooden plough, practically the same as the old Roman plough, might have been seen at work as recently as 30 years ago. France is now well to the front in the matter of agricultural machinery, and is very well provided with workshops where implements are made and repaired. In every European country implements of all kinds have been designed to suit the requirements of various soils and various crops; and the process of specialisation and evolution is being pushed on with skill and perseverance. It is

cheap iron which has made this possible. In the Deccan there is little movement so far; but something is being done. Pickaxes which were introduced by the Engineering Departments are now becoming quite popular, and hundreds of iron turn-wrest ploughs are purchased annually. A machine which has advanced many stages during the last century is the sugar-cane mill. The old stone mills, containing a hole in which the cane was pounded may still be seen lying about in the fields. They were replaced about 100 years ago by a two-roller wooden mill, which was a great advance. These in turn have been supplanted in most parts during the past 15 years by the three-roller iron mill; while during the last few years several power-driven crushers with six or more rollers have been erected; and more are likely to be erected in the near future. So long as it is necessary to import iron implements from other countries, it is impossible that the detailed attention necessary to adapt them to local requirements will be forthcoming: but already in the Deccan several iron foundries have been started for the manufacture of agricultural implements. Iron will very shortly be produced in India; and the day is not far distant when India will be in a position to make agricultural implements designed for its own special purposes; and to provide effective workshops for their repair. When that day arrives, the cultivators will not be slow to recognise where their advantage lies.

The chief advantage of efficient implements is, of course, that they save time and cheapen production. It does not end there, however; for there is many a man who would be ready to take up agriculture if he could work with efficient machines; but who prefers to stand out of it altogether rather than to use the primitive methods in common use. This is a matter of some importance in the present day when the educated classes are beginning to think of farming as a profession; and doubtless accounts for the interest that such men often display in the question of advanced agricultural machinery. Meantime it must be recognised that in the matter of dead stock the Deccan farmer is very badly equipped. Looking at stock as a whole, live and dead, we may

take a substantial cultivator with 40 acres of unirrigated land and allow him the following:—

		Rs.
Two pairs of bullocks at Rs. 75 each bullock	...	... 300
Four cows at Rs. 30 each	... ...	... 120
Implements	... ...	... 80
Ready cash	... .	... 100
	Total	... 600

His capital figures out at Rs. 15 (£1) per acre; whereas the tenant farmer in England is expected to have for the same purposes £10 (Rs. 150) per acre.

VIII.—Circulating Capital.

Under this heading may be considered the grain, fodder and manure which are kept in hand.

Grain. Under ordinary conditions in India the striking thing is how very little produce the farmer has in hand after harvest is over. His general shortness of capital causes him in most cases to cut down this form of capital; in other words to convert into money, as soon as possible, any produce that he can collect from his fields. He can seldom afford to stack his harvest, and thresh, winnow and market it at his convenience. If he were able to do so, he might get on with his ploughing in the cold weather, before the ground is too dry and hard, and dispose of his produce in the hot weather when field operations are brought to a standstill. But he generally cannot afford to stand out of his money for so long, and he puts his produce on the market at a time when everyone else is doing the same, and prices are at their lowest. In many cases he obtains an advance against the crop, and in such a case his only concern, at harvest time, is to adjust the balance with the sowkar (money-lender) in whose hands he has placed himself. If the cultivator could afford to hold up his produce longer he could doubtless obtain better prices and suit his convenience better. The question of holding up produce for a good market, must not be confused with the question of keeping a permanent reserve of grain. It is

common to hear old people deplore that, now a days, cultivators do not maintain a permanent reserve of grain as they used to do. Formerly, in out-of-the-way tracts, grain was stored to a great extent in the villages; but now, few people keep more than enough to last them till the next harvest. It is, however, doubtful whether this change is a matter for regret. Grain was formerly permanently stored by cultivators, because there was no ready market for it. Now a days they can always find a market for selling and for buying grain, and they keep no permanent reserve. It is argued that the money so obtained is spent at once, and that the man is worse off for not having his reserve of grain. It is certainly a fact that the standard of comfort has risen; but the standard is not so high that we need deplore this. Under modern conditions there is no difficulty in marketing produce, no fear of the grain becoming exhausted in any locality, and far less fear of lack of employment. The poorer classes have adapted themselves to the new conditions.

Fodder.—The extreme shortness of fodder has already been remarked upon. In many tracts hardly any store is carried over from one year to another, and little even to the hot weather. A striking fact noticed in the recent famines was that some of the tracts where fodder was usually most abundant, such as Khandesh, suffered most severely, and lost more cattle than the localities which ordinarily produce far less fodder. In many localities fodder is so scarce even in an ordinary year that it is very difficult for the people to store it against a famine; but in other tracts where it is usually plentiful, its value is overlooked, and it is largely wasted. Unlike grain, fodder cannot be readily imported from a distance to supply any local deficiency. Its bulk prevents this; and when transported to a distance the cost of carriage makes its price prohibitive. There is probably a good opening in the Deccan for compressed fodder which is easily portable and can be kept for a long time. Kadbi (jowari stalk), the common fodder of the country, may often be found selling at one place at 500lbs. to the rupee, and at another place not far distant at 50 lbs. to the rupee. This, however, is a matter for experiment and enterprise.

The ordinary cultivator must maintain his own fodder reserve if he would avoid disaster.

Manure.—The cultivator of dry crops in the dry tract sets little value on manure. He stores carelessly what farmyard manure comes readily to hand; but would never buy it. In tracts of better rainfall the farmer values it more; but it cannot be said to be an important item of his capital. With the garden cultivator it is otherwise. He stores it carefully and buys it largely. Sugar-cane is manured at the rate of 60 cart-loads per acre. A cart-load works out at about one-third of a ton and costs about 14 annas. Where garden cultivation has increased complaints are often heard of the high price of farmyard manure; but it is still the cheapest form of manure, and its nitrogen works out at Rs. 2-10 per unit, as against Rs. 8-8 per unit of nitrogen in sulphate of ammonia, Rs. 9-4 in safflower cake, and Rs. 12-2 in castor cake on the "ton per cent." basis. Castor cake is used in some tracts as a top dressing for sugar-cane, and is a considerable item in the cane grower's bill. To the bulk of cultivators, however, manure is not a formidable item of expenditure, nor a matter of much care. Artificial manures are almost unknown.

IX.—Reserve Capital.

Provision for unforeseen expenditure, sinking fund and insurance.

There is not much to say about these forms of capital except to point out their necessity. In every business accidents may happen, and adverse periods will occur. In agriculture this is particularly the case. In the Eastern Deccan owing to the vagaries of the rainfall, a year of scarcity may be looked for once in five years, and a serious famine every ten or twenty years. Many theories are advanced as to the reasons why failure of rain should cause such acute distress. Without attempting to investigate the reasons why the cultivator has not got more capital at his disposal, it may be stated that he has little or no reserve capital; and this circumstance is a prime factor in famine distress. The landholder with unencumbered

land may raise a mortgage to tide over the period of depression; but the 50 per cent. of land-holders whose land is already mortgaged, and the landless labourers cannot do so. Field work comes to an end and wages cease. Under such circumstances the farm labourers in England could not afford to remain idle for a month; and it need not be a matter for surprise that the poorer classes in India cannot afford to remain idle for a year or more. In England, however, the capital of the landlord and the capital of the tenant farmer feel the first brunt of any depression which occurs, and tide the labourers over the crisis, with hardship perhaps, but without the deplorable accompaniments of an Indian famine.

Sinking fund.—Field improvements will go out of order, and implements will wear out. The farmer who does not provide for these contingencies by laying aside a certain sum every year as a sinking fund is bound to find himself in difficulties sooner or later. In considering the question of purchasing expensive machinery the questions of depreciation, repairs and interest are very important. Suppose a man buys a small power cane crushing plant costing Rs. 4,000, he will probably have to allow at least 15 per cent. a year to cover these items; that is to say, he must set aside Rs. 600 a year for the purpose. If he can only run his plant for two months in the year this will amount to a charge of Rs. 10 for every working day. If, however, he can run his plant for eight months in the year the charge on this account per working day will come to only Rs. 2½. It is on such questions that the financial success of machinery of this kind largely depends. The same argument of course holds good in the case of an iron plough, costing Rs. 40 as in the case of more expensive machines. And if the establishment of a sinking fund is necessary to replace working capital laid out in machinery and implements, it is even more imperative in the case of a man who raises a mortgage on his land for unproductive expenditure. If he fails to establish a sinking fund to pay off the mortgage he is almost certain to involve himself in serious difficulties. A sinking fund need not, of course, consist of a stock of cash put

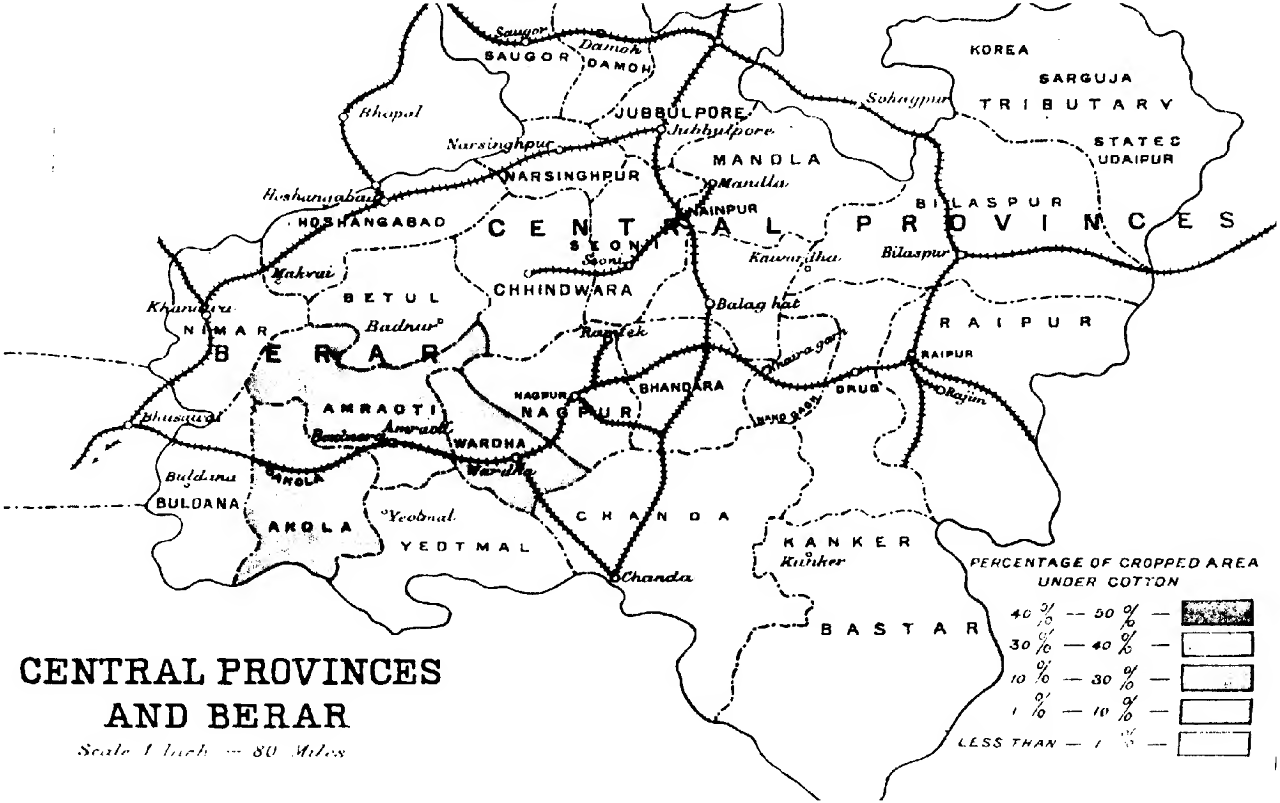
away from year to year. It may be invested in any operation that may be counted on to bring in the money when it is wanted. If the money is wanted in four years, a calf bought for (say) Rs. 20, and reared to be a bullock worth Rs. 100 or more, may represent the sinking fund. If the money is wanted in thirty years a man may plant out a few acres of teak or babul, and realise a good sum for the timber or fuel when the time comes, without more cost to himself than some of his spare time in the interval. The essential thing is that the necessity for a sinking fund should be realised, and the money ear-marked for the purpose.

Insurance.—In western countries a man will insure his stacks against fire, and may insure his live-stock against loss by disease. In India he cannot well do either. In some of the richest parts of the Deccan intentional stack-burning is very common, and, apart from the actual value of the stacks burnt, does much to discourage cultivators from keeping a permanent reserve of fodder. A man who puts up a *Kadbi* stack in his field has given a hostage to his enemies. It is not so much that the Maratha Kunbi is essentially a quarrelsome or mischievous man, as that the small-holdings and infinite sub-divisions of the land, and the absence of fences, afford endless opportunities for disputes. The exact position of a boundary, the trespass of cattle in a standing crop, a question of right of way or water may easily give rise to a dispute which will last for years and involve many stacks in flames. In such cases criminal prosecutions do not serve much to smooth down matters; and nothing but strong and organised local opinion can suppress the practice of arson which is far too common in many parts of the Deccan.

Even in Europe the insurance of ordinary farm stock is hardly a practical proposition. A particularly valuable animal may be insured; but the rates offered by Insurance Companies are usually prohibitive in the case of ordinary farm stock. Good results have been obtained in some countries by mutual insurance on co-operative principles. Such a system is, however, not at present applicable to India. All that the Indian cultivator can

do to secure himself against accidents and damage is to have his house in his fields, so that he may be on the spot to protect his property, a reserve of fodder to make his cattle secure against famine, an enclosed pasture in which he may segregate them when contagious diseases occur, and an irrigation well to serve as an insurance against unemployment in the dry season.

Conclusion.—The most important points have now been considered in connection with the land, the cultivators and the resources which they have or should have at their disposal. There are many important matters to which no reference has been made, such as the question of markets and prices, the necessity for keeping careful farm accounts, and the advantages of co-operative credit. Such questions are of vital importance to the farmer: but are beyond the scope laid down for this article. Where statistics have been given it will be noticed that they relate to classes or to large tracts rather than to individuals. Writers on agricultural economics of other countries commonly illustrate their arguments by giving detailed figures for some farm or estate, and inform the reader that these figures have been obtained from a careful study of the accounts for twenty or thirty years of such and such an estate. In the Deccan it is impossible, or at any rate very difficult to find any accounts of this nature. It is quite possible, however, for anyone who sets about it to collect detailed facts and figures of the nature indicated; and there must be many men from our agricultural colleges who are well equipped to collect such. A little precise information so obtained is worth more than any amount of theory; and if this article results in inducing anyone to undertake such enquiry its object will have been fully gained.



CENTRAL PROVINCES AND BERAR

Scale 1 Inch = 80 Miles

COTTON CULTIVATION IN THE CENTRAL PROVINCES AND BERAR STUDIED FROM AN ECONOMIC ASPECT.

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No crop in the Central Provinces and Berar has received more attention within the last half century than cotton. Within that time the mill consumption of the raw material in Great Britain, America, India and the Continent has increased enormously. There has been considerable variation in the prices from year to year, but they have always remained sufficiently high to make the cultivation of this crop more profitable than that of any other grown in the cotton tract. Bumper crops in India itself have little effect in lowering prices, as the world's supply of the raw material is never quite equal to the demand. Prices have, therefore, remained high, and the wealth amassed in the cotton tract of these Provinces has been very considerable. Wealth has brought in its train many desirable features: it has raised the standard of comfort of the whole population of the tract. Their homesteads are commodious and comfortable, and their cattle are the best to be found in the Provinces. The people are better educated, too, and more enterprising.

The area under cotton, which in 1868-69 was only 2,037,617 acres, had increased to 4,176,561 acres 40 years later (1908-09): while in 1909-10 it had topped $4\frac{1}{4}$ million acres. The great increase in the area has been largely at the expense of wheat and millets. The rapid expansion in the cultivation of this staple has, in no small degree, been due to the improved railway facilities which have been introduced within the last half century.

Previous to that time the Central Provinces and Berar were almost inaccessible. The two great cotton marts outside the Provinces were Bombay and Mirzapur on the Ganges, to which cotton was carried by road by the Banjaras. The load (bojha), of about 240lbs. consisted of two loose bags slung pannier-fashion on a bullock's back. The cost of transport in this way often exceeded half the value of the cotton. Much loss was suffered in transit, too, for the cotton was eaten by the bullocks, stolen by the drivers and damaged by the dust. The dirty state in which this fibre had been exported had long been a cause of complaint among English mill-owners. Previous to that time little inducement had been offered to the grower to supply clean cotton, as no more was given for clean samples than for dirty ones. The ryot was, it is said, in the habit of sowing his cotton broadcast in certain districts as a mixture with *tur*, *juar* and other crops; he seldom did any weeding and did not start picking till all the bolls had matured. The village *bania* as middleman adulterated his purchases with cotton seed, earth and water; there were as yet no European agents stationed in the Provinces to set the standard of honesty in the trade. The exporter, who was directly interested in getting cotton of good quality, was stationed in one of the big marts and never came into direct touch with the producer, who, therefore, remained in ignorance of his requirements as to quality. It is not surprising that under these conditions Indian cotton became a byword among English mill-owners, whose opinion was that it would never be used by them, except as a make-shift in the event of a shortage in the American supply.

The first real attempt at improvement of this staple in these Provinces dates from 1866, when Mr. Rivett Carnac was appointed Cotton Commissioner, (i) to introduce foreign staples, (ii) to improve the indigenous plant, and (iii) to watch over all affairs relating to cotton and to further, so far as might be legitimately possible, all interests connected therewith. At the time the cottons of the Central Provinces and Berar were classified as Chanda *jari*, *bani* or Hinganghat and Berar *jari* (

oomras. Chanda *jari* and *bani* were different names for the same variety, which was known as Chanda *jari* when grown as a cold weather crop in the district of that name, and as *bani* or Hinganghat when sown in other parts of the cotton tract in the beginning of the rains. The staple of this cotton was described 40 years ago as being fine and silky and quite suitable for the English mills—being nearly equal to middling American. It is interesting to note that samples of the selected *bani* now grown on the Akola Farm have this year been valued at 8·40*d*. per lb., when middling American was selling at 8·07*d*., which proves that this, our long-stapled cotton, has been improving rather than deteriorating in the quality of its staple. Berar *jari* or *oomras* was slightly inferior to Hinganghat: the name was applied very possibly to all cottons containing a mixture of *bani* and the finer types of *jari*. The Cotton Commissioner decided to concentrate his attention on the improvement of *bani* or Hinganghat mainly, and to improve it by seed selection. Large quantities of Hinganghat seed from the locality of the same name were sent to Berar, Nimar, Jubbulpore and Chhattisgarh, as well as to other Provinces. In 1867, 855 tons of seed of this variety were distributed. The results were disappointing: *bani* did badly in most places and from the selection of seed no results of proved value were obtained. Trials made with American cottons at this time proved equally unsatisfactory. Though grown with great care, they gave poor yields of lint and the fibre was weak. The efforts made to facilitate transport, however, were much more successful. Owing largely to the exertions of the Cotton Commissioner the rolling-stock of the country was increased, new branch lines were opened, suitable yards for storing cotton were provided, and baling presses were introduced. Though the highest expectations formed at the period of the American war were hardly fulfilled, the course of the cotton trade was, after the first five years, one of steady progress: gins and factories sprang up one after another, and the control of the trade tended steadily towards Indian hands, the pioneer European firms dropping out one after another.

The next important attempt at improvements dates from the year 1904, when the Government of India, in response to an appeal from the British Cotton Growing Association, urged Provincial Governments to take up the question of cotton improvement once more, and suggested the following lines on which it might be carried out. (i) The botanical examination and classification of all existing varieties of cotton, both wild and cultivated. (ii) The introduction of better varieties and improved methods of cultivation. (iii) The provision and distribution of good seed of the varieties ordinarily grown. Steps were again taken in these Provinces to improve this staple: but, strange to say, forgetful of the failures of the past an attempt was made once more to push *bani* at the expense of *jari*, which needless to say once more ended in failure. Very few cultivators could be induced to purchase *bani* seed, which the Department had collected for distribution, and those who did were dissatisfied with the poor yields of lint obtained.

In 1906 it was decided to work out a scheme of improvement on scientific and economic lines with the sole aim in view of benefiting the grower. The different indigenous races were classified, and plant-to-plant selection was started in the case of each. Exotic varieties were freely tried, and field experiments were started, designed to ascertain the relative values, from an economic aspect, of these, and of the indigenous cottons.

The result of the classification of the cottons grown in all the cotton-growing taluks showed that the so-called *jari*, the almost universally prevailing type, consisted of a heterogeneous mixture of different races—the plants of which differ greatly in their habit of growth and in the quality and quantity of their lint. In the classification I was guided by the work previously done by Prof. Gammie whose assistance throughout has been invaluable. The character of the mixture was found to vary greatly in different parts of the Provinces. In the Tapti valley and Nimar the finer types, *viz.*, *malvensis* and *vera* predominate in

quality the lint of this mixture is probably very similar to that of the *jari* or *oomras* grown 50 years ago. In the South including all Berar, where cotton cultivation is more advanced and the cultivators more intelligent, the coarser but more productive types, *viz.*, *rosea* and *rosea cutchica* were found to be in excess: this mixture is commonly known as Berar *jari*, *katevilayti* or *varadi*. Its origin is doubtful: it is said to have been introduced from Khandesh. The classification of 6 typical samples, three from the Central Provinces and three from Berar, is given below :—

Locality.	Percentage of				
	Malvensis & bani.	Vera.	Rosea	R. cutchica.	Upland American.
Hoshangabad, C. P.	26	61	12	0	1
Nimar, C. P.	38	55	0	5	2
Bhopal	57	42	1	0	0
Kelapur, Berar	14	7	37	26	16
Amraoti, Berar	19	22	33	24	2
Ellichpur, Berar	16	16	59	8	1

The *jari* types in most cases form at least 90 per cent. of the mixture: the remaining 10 per cent. being made up of American Upland varieties, locally known as *gogli* kapas and *bani*. These cottons vary greatly in the quality of their staple and in their percentage of lint to seed. The lint of *bari* and *bani* is nearly 1″ in length, while that of the *roseas* is but little more than ½″. Rosea gives 39 per cent. of lint to seed, while *bani* gives 26 per cent. only. As it was found difficult to discriminate between *bani* and *malvensis*, when there was no lint available, they have been classed together. The former, however, forms only a negligible part of the mixture except in a narrow strip of country bordering on the Nizam's Dominions and far from the railway. The repeated attempts made to restore its pristine glory have failed, because the ryot knows that it is a poor yielder, that it is difficult to pick, as the bolls are so small, and the plant so tall and straggly, and

that it is less hardy than *katervilayti*. The percentage of exotic cotton of the Upland type in the mixture varies from 1 to as high as 15 per cent.; but it generally falls below 2 per cent. A trial of numerous exotic varieties resulted in *buri* being selected as the most promising. It has since been proved to be immune to wilt disease, and to be more suitable than *jari* for districts where the rainfall is high.

In the past far too much stress has been laid on the importance of quality of staple as opposed to quantity. In the absence of accurate knowledge as to the outturn per acre, ginning percentages, and relative values of the lint of the different races grown, the methods of improvement adopted were largely based on the requirements of Lancashire Mills. What was good for the ryot was lost sight of. After having gained a fuller experience we are compelled to admit that, under present conditions, quantity is a more important consideration than quality, and that over $\frac{9}{10}$ of the cotton area *rosea* is the variety which will pay best. Many buyers never look at the length of the staple at all; those who do, pay more attention to such good qualities in the lint, as "freedom from dirt," "bulk," "colour" and a high ginning percentage, than to length of staple. This is easily understood when one takes into account the great demand there is for short stapled Indian cotton in Europe and Japan. To get the full market value for a long-stapled cotton in India it must be sent to an agent who has a special purpose for lint of that class. The grower seldom has the business acumen to do this, and therefore loses heavily when he grows a cotton of superior staple; but, even if the full market value were paid, it would be exceedingly hard to find any long-stapled cotton that would compete with *rosea*, which gives a heavy yield of cotton of a kind which is much in demand. In these Provinces arrangements have been made by the Department of Agriculture to collect and sell the long-stapled cotton grown to the Empress Mills, Nagpur. Though the prices paid by the Manager, Khan Bahadur Bezonji, compare very favourably with the valuations of the same cottons in Manchester, it is

evident from the statement below that, even after making these rather troublesome commercial arrangements in the interests of the grower, *rosea*, on account of its yield and very high ginning percentage, is easily the most profitable variety for the cultivator to grow.

Variety.	Average yield for 4 years in lbs. per acre. Of Kapas.	Of lint.	Of seed.	Value at this year's prices in Nagpur. Rs. As
G. Neglectum malvensis	373	112	261	57 5
" " vera	343	115	228	51 11
" " rosea	402	161	241	69 14
" " rosea cutchica	412	150	262	66 [illegible]
Berar *Jari*	371	132	239	58 5
G. Hirsutum *buri*	[illegible]	[illegible]	[illegible]	57 15
G. Indicum *bani*	[illegible]	74	[illegible]	44 3

It is certain that large quantities of such long-stapled cottons as *bani* and *buri*, which Lancashire requires, could be grown in the Central Provinces and Berar should the prices paid for the lint prove remunerative to the grower. At present they do not, except under the very special conditions to be noted later. It will be gathered from the statement below that, if we were to deal directly with Lancashire instead of disposing of the lint locally, the price realised for our short-stapled cotton, relative to that of middling American, would be even higher than the trade pays for it here and that to substitute a long-stapled cotton for it would, under these circumstances, prove still less remunerative for the cultivator. By exporting his cotton to Lancashire he would, under the most favourable conditions, get about 33 per cent. more for a long-stapled cotton such as *bani* than for his short-stapled *rosea*; but the outturn of lint of the latter would, on the other hand, exceed that of the former by about 117 per. cent., so that, if he were to grow and

export *bani* at present prices, it would be at a comparatively heavy loss.

Variety.	Valuation of lint per lb. in December 1910 by— Manager, Empress Mills, Nagpur.	Wolstenholme and Holland, Liverpool.	Gaddum & Co., Manchester.	Middling American.
Rosea ...	6·49*d*.	7*d*.	6·75*d*.	8·07*d*.
Malvensis ...	7·42*d*.	8·20*d*.	7·75*d*.–8*d*.	
Buri ...	8·67*d*.	7·90*d*.–8*d*.	8*d*.–8·25*d*.	
Bani ...	8·81*d*.	8·40*d*.	8*d*.–8·25*d*.	

The purchaser pays the same price for the lint of pure *rosea* as for that of the Berar *jari* or *katevilayti* now grown over nearly all the cotton tract: but *rosea* gives a ginning percentage of 39, while in the statement below, kindly supplied by the Manager, Empress Mills, Nagpur, it will be seen that for Berar *jari* the percentage for the past three years has been about 35 only: so that *rosea* will give 10 per cent. more lint than the mixture at present grown.

	Ginning percentages obtained at factories. 1908-09.	1909-10.	1910-11.
Yeotmal	35·17	34·16	33·85
Akola	35·00	35·43	31·38
Amraoti		35·71	35·40
Nagpur	35·07	35·77	34.65
Wardha	34·33	35·19	34·29

Rosea is a hardy variety and therefore suffers less than others from the vicissitudes of the climate and the cracking of our black cotton soil; it is the earliest, too, of all the races grown, and its seed gives the highest germinating percentage. It is capable of great improvement in its ginning percentage by plant-to-plant selection. The selected strain which is now being propagated on the seed farms has given an average of 40·3 per cent. of lint. If it were possible to substitute *rosea* for the *katevilayti* now grown, the higher ginning percentage alone

would in a normal year result in an increase in the Central Provinces and Berar of 51,000,000 lbs. of lint. We believe that this is possible and that to effect it merely requires time and organisation, as the cultivators everywhere are clamouring for the seed.

At present prices there is no possibility of growing *bani*, except at a comparative loss, owing to its low ginning percentage. An effort has been made to raise it by selection, and one strain has been improved to the extent that it gives 29 per cent. of lint; but even at that it is hopeless to think of growing it at a profit.

Rosea cutchica is slightly inferior in the quality of its staple to *rosea* and gives from 2 to 3 per cent. less lint.

Malvensis and *vera* give about the same outturn of lint, which is nearly equal in quality to that of *bani*. There is great variation in the quality and percentage of lint of different strains of *malvensis*, and it is therefore believed that there is much scope for that reason for its further improvement.

At present prices it pays to grow *buri* in fields where *deshi* cotton is subject to wilt disease, and this is being done. Many cultivators who have tried it have found that it pays, too, when grown in the well-manured *khari* soil found near the villages. In the rice tract where the rainfall is high, it has done distinctly better than *deshi* cotton.

Plant-to-plant selection of all these different cottons has been carried on continuously during the last 5 years and all the seed sown on the experimental farms has been propagated in each case from a single mother plant. The seed of these selected strains of *rosea*, *buri* and *malvensis* is supplied to the different private seed farms whose owners in turn distribute it to the cultivators. From the experimental and seed farms 120,000 lbs. of seed were distributed last year: about 150,000 lbs. will be distributed this year: while next year, if the crop is a normal one, the distribution will run up to at least 200,000 lbs. There are already 42 of these seed farms in existence, scattered over 16 taluks. Selected seed will continue to be supplied to

these from the experimental farms, where selection is carefully supervised. The owners of seed farms fix their own rates and arrange for the sale and distribution of their own seed: the Department of Agriculture advertises it for them as widely as possible. Till this year, the selected seed for these farms was supplied by the Department free of cost; as they have now become popular institutions, and as the merits of seed selection are becoming more widely appreciated, those who have started new farms this year have agreed to pay the full market price for the Department's selected seed. All these farms will be run on that footing next year. They will therefore be entirely self-supporting in future, and the duty of the Department regarding them will consist in supervision with the view of ensuring honest dealing, in widening the distribution of seed of the variety specially suited to the locality, in keeping in touch with the owner, and in popularising and extending the system of distribution to other centres. The system is based on the assumption that the owners, nearly all of whom are enlightened members of the Agricultural Associations, are sufficiently honest to sell as selected seed only that which they have raised each year from the improved strains supplied by the Department. The seed supplied to them being of pure strains, it necessarily follows that, in the event of their adulterating it with their own inferior seed, their sins will find them out in the mixed crop raised from it, and that they will soon lose any reputation they may have gained as seedsmen. No such case of adulteration has yet been reported, and we believe that, by exercising efficient supervision, we are in a position to put an end to the practice, should it arise.

The greatest difficulty of all is that of getting the *kapas* ginned without injuring the quality of the seed. Up to the present nearly all the seed has been hand-ginned. As these farms have increased in number, however, great difficulty has been experienced in getting sufficient labour at the proper season. During the picking season, *i.e.*, from October till January, the women coolies are employed in the juar and cotton harvest, and

the seed-grower has therefore to store his *kapas* till the slack season comes round which coincides with the beginning of the hot weather. By that time the price of lint has generally fallen; moreover, the buyer reduces the price still further, on the ground that the cotton has been hand-ginned and is therefore 'dirty.' The grower has still another difficulty to contend with: in the event of plague breaking out in his village, flea-infected plague rats sometimes harbour in the *kapas* and die there. In the light of these facts it has been decided to get the work done in future by power rather than hand gins. All the seed cotton of the Experimental Farm, Akola, has been ginned for the last 4 years on two Platt's gins driven at a slow speed by a small 5 H. P. steam engine. The germinating percentage of the seed ginned in this way is as high as that of hand-ginned seed. Arrangements are now being made to set up similar ginning plants but with an oil instead of a steam engine. We thus hope to have the whole cotton belt studded with hundreds of village seed farms, with small central ginning factories here and there, capable of dealing with all the selected cotton grown thereon. These farms will also continue to serve as centres at which seed of new varieties will be grown for distribution. Of *bani*, the new variety recommended for certain classes of soil, seed for 3,000 acres was distributed in this way last year while this year twice that quantity will be dealt with.

We believe that a great and permanent improvement of cotton can be effected by working thus *from within*. The trial of exotic varieties will be continued, but here the difficulties in the way of attaining success are greater owing to the soil and climatic conditions being unsuitable for long season cottons. The rainfall of the cotton tract ranges from 30" to 45" annually—nearly all of which is obtained during the first three months of the growing season, *i.e.*, from the end of June till the end of September. After this the dry weather sets in and exotic cottons suffer from "red-leaf blight." Sometimes, too, they are still further damaged by frost in December or January. Requiring as they do a longer growing season, they are subject to

forms of damage which our indigenous varieties, being earlier and hardier, escape. Of the exotic varieties tried up to date, *buri* is by far the most promising. It is comparatively early. It is, moreover, immune to wilt disease, and therefore meets a distinct want in this part of India, where, owing to continuous cropping with cotton, this disease is in places becoming serious.

THE INTRODUCTION AND SPREAD OF CAMBODIA COTTON IN THE MADRAS PRESIDENCY.

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THE introduction of Cambodia cotton into the Madras Presidency is perhaps one of the most striking instances in India of how readily the ryot will take up a new cultivation, if once he is satisfied that it pays him to do so. In this case, it is still more remarkable because cotton is no new crop to the ryot and the cultivation of this Cambodia cotton is very different to the methods of cotton cultivation known for generations to the ryots of the Southern Districts. The indigenous cotton has always been essentially a rainfed crop of the black cotton soil. This, in the dry climate of these districts, cannot stand heavy manuring which tends to keep the root system near the surface. Cambodia cotton, however, if it is to pay, has to be grown as an irrigated crop on heavily-manured soil, and if anyone had five years ago told the ryots of Tinnevelly, Ramnad and Madura, that in five years' time their best garden lands, *i.e.*, heavily-manured made soils under well irrigation, would be sown with cotton as an irrigated crop, the very idea would have been laughed to scorn. Yet this is what has happened even to the ousting of such profitable crops as chillies and tobacco.

Cambodia cotton very closely resembles American Upland and is probably of the same species. It is, however, in this climate, much hardier and more vigorous and gives a stronger and fuller lint than either newly introduced American or acclimatised Dharwar American. Its root system closely resembles that of American Upland, *viz.*, a tapering tap-root with strong

feeding roots given off near the surface, and differs greatly from that of the indigenous cottons which have a long slender tap root with very slender feeding roots penetrating deeply into the soil. It can be understood, therefore, why it is that Cambodia responds so readily to irrigation, and how, since the crop is protected from drought, it is possible to manure heavily and obtain very heavy yields, and it can also be understood why this crop, if grown on black cotton soil with the aid of rain alone, cannot resist prolonged drought. On well-manured land under irrigation the yield is usually stated to be from 1,250 to 1,600 lbs. of Kappas and never less; while yields as high as 2,500 lbs. have been reported. With a ginning percentage of 33 to 35 of lint, an acre will, at this rate, give about a bale of lint (500 lbs.) or over.

Cambodia cotton was first introduced into this Presidency by Mr. C. Benson, the late Deputy Director of Agriculture, Madras, who in 1904 obtained a small quantity of seed from Monsieur A. Paulain, the President of the Chamber of Agriculture, Pondicherry. This was sown on the Koilpatti Agricultural Station as a dry crop on black cotton soil. Sixty-four lbs. of Kappas were obtained from an area of 20 acres. This was again grown in 1905 and the following years, but its root habit showed that it was unsuited to black cotton soil in a dry climate. In 1907, a year of heavy showers in the latter part of the picking season, it responded very readily to these and gave a yield greater even than that of the indigenous black cotton soil cottons. Such years, however, are the exception and not the rule.

In 1905, Mr. A. Steel, of Messrs. A. & F. Harvey, Virudupatti, happened to find in a loose bundle of Kappas, some of this same Cambodia Kappas, and he called this cotton "American," it being of the same class as American Upland, by which name it is now known throughout the districts where it is grown —and even on the Liverpool market it is known as "Tinnevelly American." On enquiry as to the origin of the bundle, he learnt that this also came from Pondicherry. Having a

piece of land (black cotton soil) near the Press, he sowed some of the seed in 1905, and in 1906 got a fair yield sufficiently encouraging to make him continue the trial the next year. 1906-07 happened to be a very favourable year for cotton and, as already mentioned, Cambodia cotton yielded well this season at Koilpatti. Even then, in spite of the favourable season, ryots, so Mr. Steel informs me, who saw the crop, suggested that it should be irrigated. Virudupatti being probably the chief centre of the cotton trade for "Tinnevellies" and a place which the cotton-growing ryot frequently visits, was an excellent place for such a promising trial, and there was a regular scramble to get the stock of seed which Mr. Steel had to dispose of. This was sown by ryots on lands which could be commanded by irrigation. The 1907-08 crop amounted in all to 40 bales (of 500 lbs.), and the seed obtained from this was eagerly sought for. Most of it was sold in small lots at fabulous rates, as much as 4 as. a pound being, in some cases, paid for it. In 1909, 1,650 bales were pressed and in 1909-10 the cultivation had spread so rapidly that the crop realised nearly 7,500 bales (of 500 lbs.). No definite information is available as to what the 1911 outturn will be, but Mr. Steel estimates this at between 25,000 to 30,000 bales (of 500 lbs.) or about 25 per cent.* of the probable outturn of the Tinnevelly crop. Since Cambodia cotton is not grown on ordinary cotton soil, but on garden and irrigable land, this hardly affects the area or the outturn under ordinary "Tinnevellies."† The outturn of Cambodia cotton may therefore be looked upon as an addition to the ordinary "Tinnevelly" crop.

The cultivation of Cambodia cotton thus, to all intents and purposes, commenced from Virudupatti, though seed has also been distributed from the Koilpatti Agricultural Station to several persons throughout the Presidency and several centres

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* The Government final outturn report for ryotwari land of "Tinnevellies" is 42,900 odd bales of 400 lbs., i.e., only 20 per cent. more than Mr. Steel's estimate of the Cambodia outturn.

† This does not, however, include Zemindari land and the 25% given above is Mr. Steel's figure for the proportion of Cambodia to total outturn of "Tinnevellies."

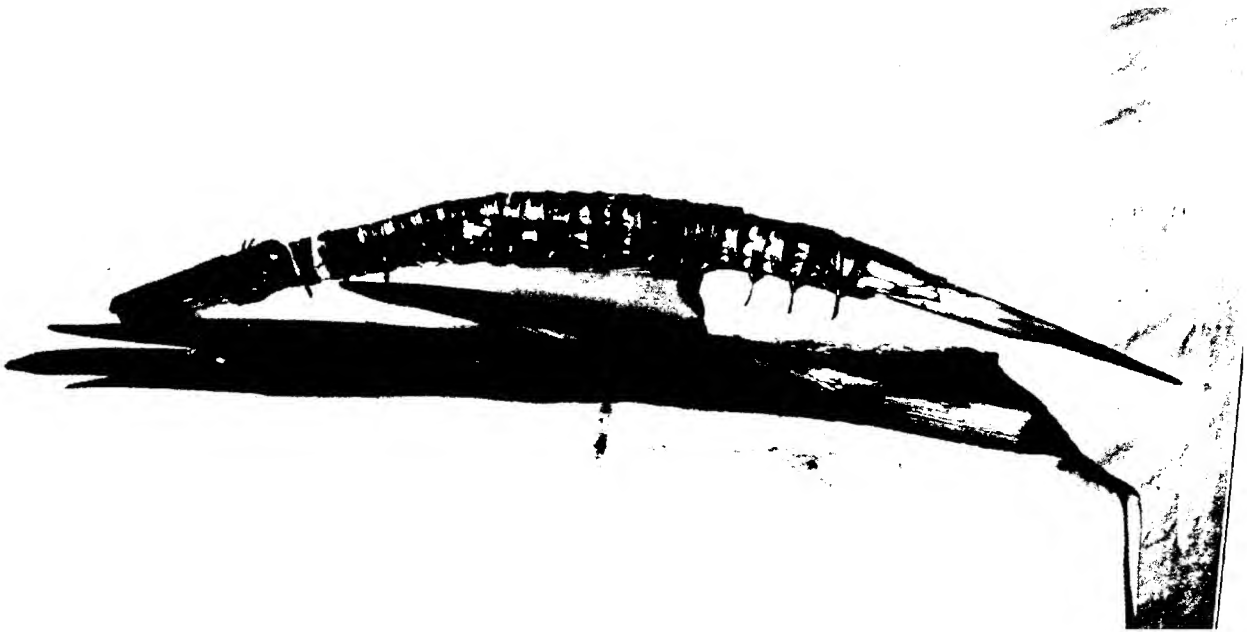
of cultivation can be traced to this origin. From Virudupatti it spread chiefly westwards towards Srivilliputtur and from there northwards into Tirumangalam Taluk and the country lying near the Ghauts in the Madura District. Not only is this cotton grown on garden lands, but it also is now largely cultivated on well-drained wet land under tanks and under precarious irrigation sources which are too uncertain to ensure a paddy crop.

1910 has seen a much wider extension. From the south and west of Madura District this cultivation is creeping up into Coimbatore through Palni, and it is also extending to the east and north of Madura District into Trichinopoly. By means of the Agricultural Department this crop is also being introduced into other districts further afield, and seed has been distributed to Trichinopoly, South and North Arcot, Salem and Coimbatore in the south, while it is being tried in several parts of the north of the Presidency. Not only this, but even in Tinnevelly and Ramnad, the original starting point of this crop, wells are on all sides being sunk and garden lands are being made with the primary object of growing Cambodia cotton.

There are certain dangers ahead which, if possible, should be guarded against. One is that this being an irrigated crop, it can be sown sooner and left on the ground longer than the ordinary country cotton, and now the land is no longer left free from cotton from July till September which break did much to keep cotton pests in check. Another danger is in the mixing of country Kappas with Cambodia, and unless buyers protect themselves against this by concerted action, this mixing is bound to increase when the ryot benefits more largely in the higher value of this cotton and the reduction in value from mixing will ultimately be more felt by the ryot than by any one else.

I wish to acknowledge here not only the assistance which Mr. Steel has given in supplying me with figures and information, but also the large share he has had in introducing this cotton to Southern India

PLATE XLI



THE MANUFACTURE OF PALM SUGAR IN UPPER BURMA.

By L. AUBERT, B.A., B.SC.,

Superintendent of Land Records, Pakokku, Burma.

Palm sugar, tanyet, or,—if the Indian name be more familiar,—*jaggery* is obtained from the inflorescences of the Palmyra tree (*Borassus flabellifer,* Linn.). This palm (Burm : *Tanbin*) is well known in Burma and in India, and needs no special description.

Both the male and the female trees are tapped for their juice, from the time the first flowers appear till late in the year. In the male tree (Burm : *Tabo*) the innumerable tiny flowers are borne on a thick cylindrical spadix or flowering branch somewhat resembling finger-like growths twelve to fifteen inches long and given out at the top of the tree. The female tree (Burm : *Tamma*) bears spikes varying from a foot to eighteen inches in length, with the young berries seated all round, as in the cob of the maize plant. Both the palms, male and female, when full grown and healthy, bear from four to five inflorescences in the year, the lower ones blooming earlier, and the higher ones later in the season. The *Tabo,* which blossoms first and gives out a thickly sheathed spadix early in the month of March, opens the toddy season, which is closed late in October, when the berries have fully matured on the *Tamma.*

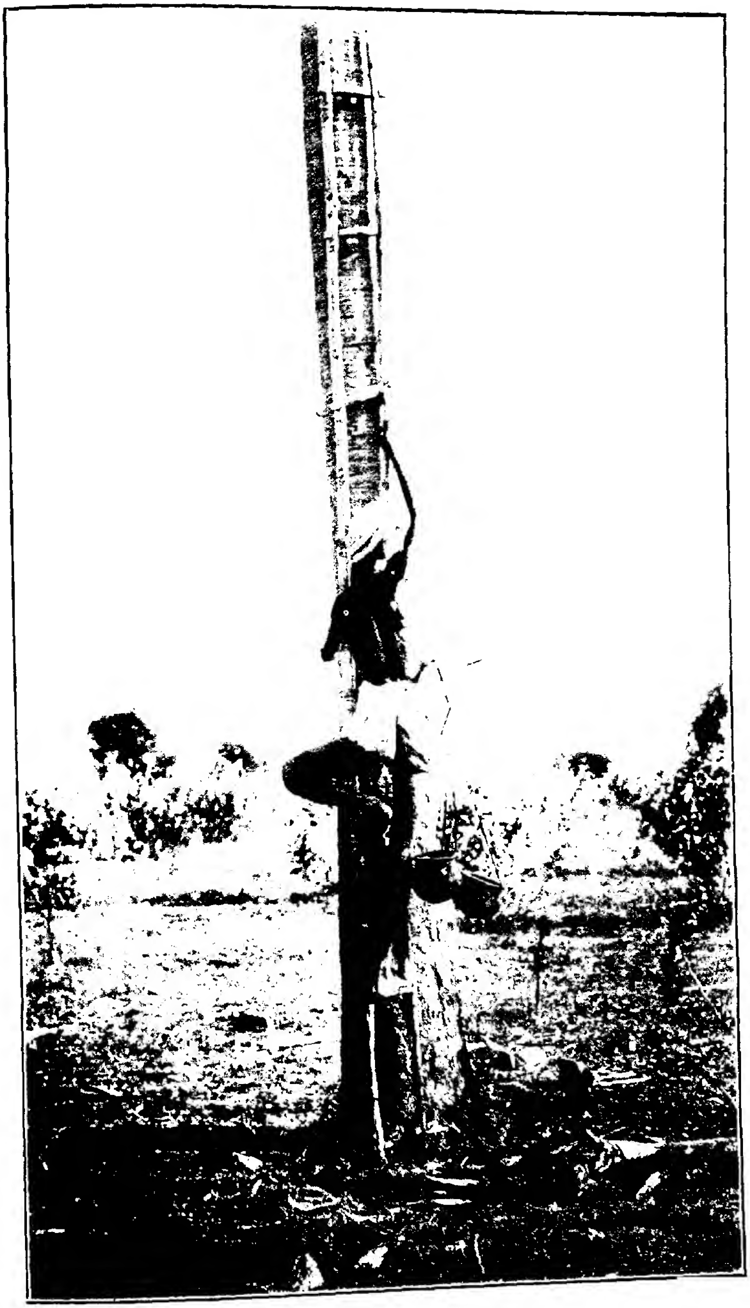
The toddy season thus lasts eight months of the year. It may be divided into three tapping phases or periods, during which the following operations are carried on : the *ngyit* and the *hnyat-thayaung,* on the *Tabo,* the *yaung* and the *thiyin* on the *Tamma.*

The first period of tapping is occupied by the *nuyit*, in the months of March and April. The practised eye of the toddy tree climber has soon fixed on his subjects, and sorted out, in the dense grove, the trees ready for him. The earlier or lower blossoms are selected first, the upper or later ones being left for the second tapping. The tree is climbed, and, with a sharp pointed knife, the external sheaths enclosing the *tanno*,* or male spadix, are removed, and its finger-like ramifications are bandaged up together with strips one-fourth of an inch wide, made from the tender young leaves of the tree. In a couple of days the *tanno* is ready for tapping. About one-third of the total length of the *tanno*, from the tip, is removed with an extremely sharp knife, the *dannee*, generally in the cool of the evening. No sap or juice flows for about 24 hours. The next day a small earthen vessel is slung up the tree and attached to the *tanno* to receive the exuding juice, which flows, at first, drop by drop: the flow gradually increasing in quantity, until the supply is exhausted, in about 40 days. The tree is climbed morning and evening. Each time the vessel attached on the previous climbing is removed: a slight incision made, a thin slice only taken off the pointed end of the *tanno*, and a fresh empty vessel,—prepared as described hereafter,—is slung up in the place of the first one taken down.

The second tapping, in May and June, consists of the *hnyat thayaung* and of the *yaung*, the two operations being carried on simultaneously. The output of the *Talo* is at full flow, and the *Tamma* is ready for its first operation. The sheaths protecting the upper inflorescences of the *Talo* have by now dropped off, those still adhering being removed with a sharp knife, *dahurin*. The bared *tanno* is squeezed with a pair of large wooden pincers, a *hnyat*, for a few minutes the first day, and again after an interval of 48 hours. The *tanno*, with all its ramifications, is then bandaged up with strips of the leaf in the manner described for the *nuyit* operation. The first incision is made after an interval of 48 hours and an earthen pot, *mye-o*, slung up in the

* Literally, the udder of the tree.

PLATE XLII



A. J. I.

Toddy Palm Climber. *[illegible]*

usual way. From this moment onwards, a fresh but slight incision must be made at every climbing, morning and evening, and a newly prepared *mye-o* slung up at each time.

While this operation of the *hnyatthayaung* is performed daily on the male tree, the operation of the *yaung*, in the early stage of the female inflorescence, is also in progress. When the young berries on the spike, *tadigaing*, are still about the size of a walnut, this *tadigaing* is beaten lightly for a few minutes the first day, with a small iron hammer, the *tadu*. This gentle hammering, with a view to bruise and relax the tissues, is done on the bare parts of the fruiting peduncle, in the interstices between the berries. The operation is repeated after an interval of two nights, and the first incision is made with the *dannee*, after another interval of 48 hours. The usual earthen *mye-o* is slung up at the tip of the spike operated on, to catch the exuding sap. Both the incision and the receptacle for the juice have to be renewed in the usual manner at each climbing.

The two operations described above have taken us to the middle of the month of June, the end of the second period of tapping. The supply of sap from the *Tabo* has stopped by now, but the *Tamaet*, the more valuable of the two for its longer and richer output in juice, is in full flow. This is the time for the *thiyin*, the third period, which lasts as long as the two others put together, closing late in October. Like the *hnyatthayaung* on the male palm, the *thiyin* on the female tree is performed on the upper and later inflorescences. The spikes are gently hammered with a *tadu*, in exactly the same manner as done for the previous operation of the *yaung*, but the first incision is made about a month after, in July, *Wazo*, when the berries are fully developed and have begun to mature. A slight incision has to be made hereafter at each climbing, and the vessel renewed twice daily, morning and evening. If all goes well and the tree is healthy, the flow of juice will go on increasing until the end of the season.

The life of the toddy palm climber, *tauthama*, is a hard one, badly remunerated, and attended often with sad accidents. Toddy tree climbers in Burma form a special class or caste: and

the profession, which requires a patient and daily practice, is handed down from father to son. An ordinary climber is able to climb, twice a day, 40 to 50 trees of a height averaging from 60 to 80 feet each, between daybreak and nine o'clock in the early morning, and again in the afternoon, between three o'clock and sunset—that is, 80 to a 100 trees in a season; 40 to 50 *Talos* in the early part, and the same number of *Tammas* during the later period. In these few hours, he replaces, at each climbing, the earthen pots, *mye-os*, fixed up on the previous occasion, for new ones prepared and placed in readiness beforehand by his wife and children at the foot of each tree to be climbed. He also hands them the vessels brought down containing the juice extracted. He carries attached to his waist his knife in a wooden sheath to which is also hooked the vessel he takes up or brings down with him at each climb.

The instruments of the toddy palm climber are varied, and consist of the following:—

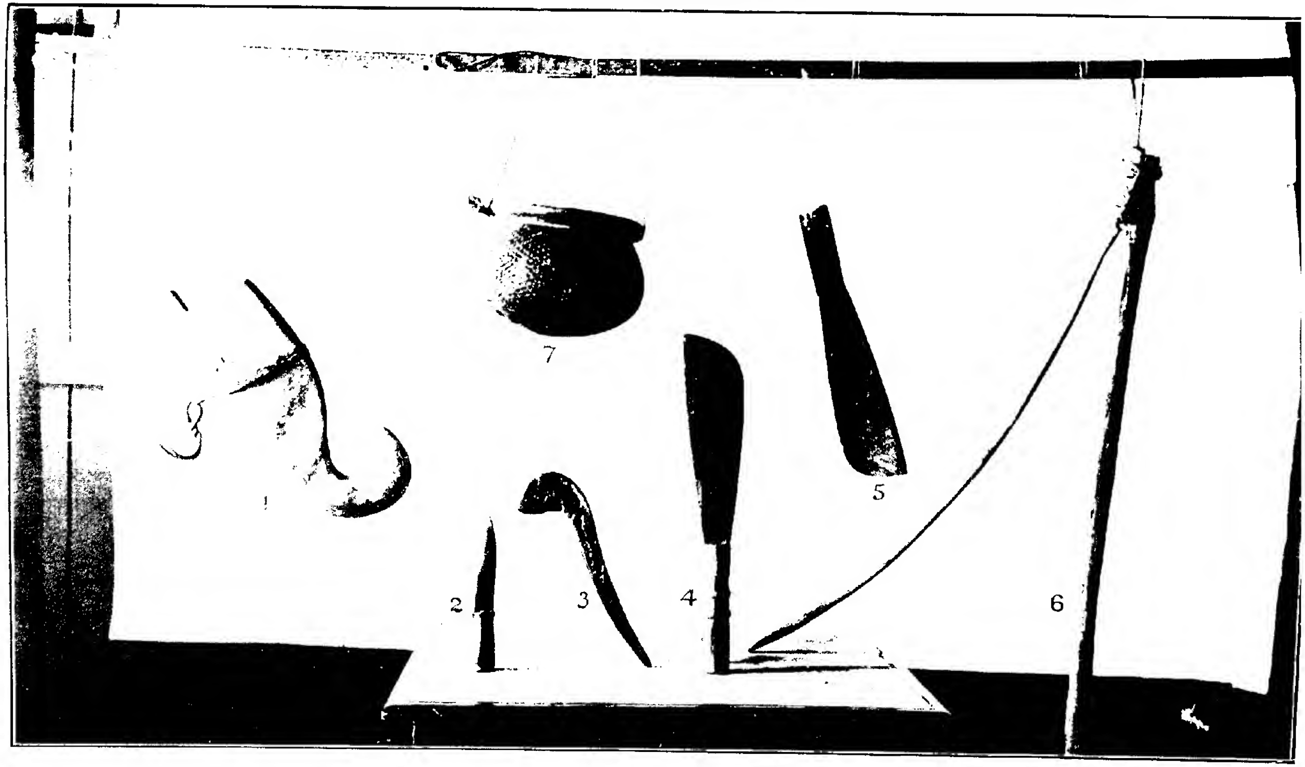
The *dachon* is a knife 18 inches long, used for trimming and smoothing from asperities the stems of the trees to be climbed, and for removing the still adhering remnants of the old dried-up petioles, before climbing can be attempted.

The *dabwin* is a small knife, 8 inches long, used at the *nuyit* operation for removing the sheaths enclosing the inflorescence, and for cutting strips of the tender leaves to bandage up the *tanno*.

The *dannee*, the most important of the series, is a very sharp knife, about 14" long, used for all incisions. It is the climber's *vade mecum*, and is placed into a wooden sheath attached to his waist. The lower extremity of the sheath is fitted with iron hooks to which are slung the pots to be carried up or brought down the tree.

A pair of wooden pincers, 3 feet long, made of two outwardly curved pieces of the wood of the *Zibin* (*Zizyphus jujuba*), and used at the second operation on the male tree for squeezing and bruising the *tanno*, is called *hnyat*: from it has been derived the name of *hnyatthayaung*

PLATE XLIII.



A. J. I.

INSTRUMENTS USED BY THE TODDY PALM CLIMBER.

(1) Wooden sheath of the *daunee*. (2) *Dabaria*. (3) *Tadu*. (4) *Dackan*. (5) *Daunee*. (6) *Hugal*. (7) *Mye-o*.

The *tadu*, sometimes called *sauk-khauk*, is a recurved iron hammer, a foot long, used to beat lightly the *tadigaing*, or spike bearing the berries at the time of the *yaung* and the *thiyin*.

An earthen vessel, 6 inches in diameter, and of the capacity of 6 pints, slung up to receive the juice after each incision, and to which reference has been made several times already, is called *myé-o*. Each palm climber stocks 300 or 400 of these for the season. They are made locally and cost Rs. 2 a hundred.

While the male member of the family attends to the tree and to the extraction of the sap, his wife and children are not idle. They too have their share of labour and their daily duties. The children prepare the *myé-os* for the next climbing and place them at the foot of each tree, beforehand, carrying back to the hut the vessels containing the juice brought down. There, the mother attends to the emptying of these vessels into large earthen cauldrons. She also attends to the boiling of the juice and to the manufacture of the *tanyet*, a general name for all qualities of palm sugar.

The preparation of the *myé-os*, before being used at first, and each time before they are attached to the tree, is an important operation on which depends greatly the quality and the flavour of the syrup. When newly bought, the pots are washed and exposed, still wet, in rows, with their openings towards a fire made of dried branches and leaves; in short, they are smoked for about ten minutes. Hereafter, each *myé-o* used is washed and dried in a similar manner at least, once a day. Just before being placed in readiness to be slung up, a few chips of the bark of the *Thitya* tree (*Shorea obtusa*), are dropped into each empty vessel. The reaction of this bark has the object to retard fermentation and seems superior to lime in its effect, as the juice retains its full amount of saccharine matter, and does not deteriorate in the least.

The boiling of the juice and the manufacture of the sugar, as noted above, are exclusively the part of the toddy climber's wife. Five large earthen cauldrons, *pyin-os*, of a capacity of $2\frac{1}{4}$

gallons each, are kept on the fire continuously. Into the first one, the day's fresh supply is poured, boiled late in the evening to full ebullition, in order to prevent fermentation, and is then put by until the next morning: when it is again boiled down to about one-third of the original quantity, until it takes the consistence of syrup. It is then transferred to the second cauldron to make room for a fresh supply.* In the remaining cauldrons, the syrup is meanwhile being reduced to treacle: the contents of the third cauldron being added to the fourth, and, in turn, to the last one, until the latter has been filled. At this stage, the treacle is taken off the fire, stirred for several hours with a long wooden spoon, the *yaunggaut*, and allowed to cool. When sufficiently cool to be handled, portions of the half solidified mass are taken out with a *yeukchit*, a small flat wooden spatula, and are quickly rolled into balls with the hands slightly moistened with water. These balls are then placed on a clean mat or on a tray, and spread out to dry in the sun. We have here the common, brown unrefined sugar generally used and exported, the *tanyet-longyen*. There are two better qualities besides: the *tanyet-lonthé* and the *tanyet-pyazôk*, classed and valued according to their degree of purity and refinement: the latter being of a whitish colour. This is made to order only, in small quantities at a time, and is not exported.

Ten *myeosi*† of juice yield 2 viss of *tanyet-longyen*‡: that is to say, a gallon of raw juice will give about a pound of unrefined sugar. This quantity varies for the two better qualities in proportion with the degree of refinement, the yield being about two-thirds less for the superior quality, the *pyazôk*. A hundred viss of *longyen* sell at Rs. 15 locally. The middle quality, the *lonthé*, fetches Rs. 20 a hundred viss: and the *pyazôk*, obtainable in small quantities only, is sold at the rate of 4 annas a viss.

* [illegible] the overflow of the boiling syrup is checked instantly [illegible] pieces of the powdered seed [illegible] (*Ricinus communis*) rubbed against [illegible] at the mouth of the cauldron.

† 60 pints.

‡ [illegible] 3·83 [illegible]

A good average tree returns 10 viss ($36\frac{1}{4}$ lbs.) of *longyan* in a season. The yield in the male and the female trees is much the same, though the *Tabo* flows only for a comparatively short period; the bulk of its supply is given out, at the time of the *hoyatthayaung*. The *Tamma* does not dry up so rapidly. It gives less in a day, but the supply is more even and reliable, and the juice richer in saccharine matter. The ripe fruit, on which cattle are fed in the dry season, and the seed add to its value. The owner's share of the produce from each tree tapped is one-third for the season; or, as generally arranged, he gets a day's yield every three days, the toddy tree climber taking the rest.

The palm sugar producing districts of Upper Burma are the Pakokku, the Lower Chindwin, the Myingyan, the Sagaing and the Meiktila districts. The following are the chief centres of export: Yesagyo, Myaing, Pakokku and Seikpyu, in the Pakokku district; Monywa and Badon, in the Lower Chindwin; Myingyan, Nyaung-u, Salé, in the Myingyan district; Sagaing and Myinmu, in the Sagaing district; Meiktila and Mahlaing, in the Meiktila district. The average exports from the Pakokku district alone, by the steamers of the Irrawaddy Flotilla Company, for the last nine years, work out to 7,500 tons annually.* It has been estimated that at least an equal quantity is exported in country boats, bringing the annual amount of palm sugar exported from that district to 15,000 tons, in round figures. Exact figures for the other districts mentioned are not available, but the total exports in each individual instance would, in the case of the Lower Chindwin district, stand at about two-thirds of the above given figure; for the Myingyan district, at about one-half only; for the Sagaing and the Meiktila districts put together, they would not reach above a quarter.

A few remarks may be allowed, in concluding, on the disadvantages of this industry. A fact that cannot escape notice is that palm sugar is manufactured in the districts of the dry zone and that the industry is, in a way, greatly detrimental to these

districts, from the agricultural point of view, as well as from an economical one—the fuel supply of the future.* It consumes a large amount of fuel and has for centuries led to indiscriminate forest-cutting. Sugar-making has been mentioned as a resource for the peasant to fall back on in bad seasons;† but it is not clear how this could be the case, as the palm trees are generally the property of a well-to-do minority, and toddy climbing is a profession practised in good and bad years alike, requiring a long training and handed down from father to son. That the industry is greatly detrimental, there can be no doubt. For miles around, at the sugar-boiling season, the country is bared of every stick of vegetation that can be found; so much so, that the people are beginning to awake to the fact that fuel, even for their domestic use, is rapidly becoming scarce. This industry did not grow in a day: it has been practised from time immemorial. There are indelible marks to show that where now lie vast, sunburnt arid areas, in the past, stood dense virgin forests. The etymology of the name of one of the largest *tanyet* manufacturing centres, Myaing, can confirm the above statement. *Myaing* means "virgin forest,‡" and there are ancient writings to prove that the country around was, at the time of the foundation of this village, clad with dense forest growth; though, at the present day, the name may sound an irony.

In times of scarcity every second cultivator met with in the jungle blames the rainfall, and often the Government: crops were abundant and the heavens propitious in the days of his ancestors. But he is blind to the true cause of the evil their recklessness, and his own, in forest cutting. If not restricted in this inconsiderate timber-wasting by the proclamation of reserved areas, not only will the industry soon be doomed to ruin, but the Burman in these parts will miss even the fuel necessary to cook his daily food

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* Pakokku Settlement Report para. 15.

† Pakokku Settlement Report para. 17.

‡ *Taw-myaing*

NOTES OF A TOUR IN THE FRUIT, SPICE AND PADDY GROWING TRACTS OF NORTH KANARA, BOMBAY PRESIDENCY.

BY E. HOLMES-SMITH, B.SC., F.R.H.S.,

Supernumerary Economic Botanist.

THE district of North Kanara is situated about 240 miles south of Bombay and constitutes the southernmost part of the Presidency having been separated from Madras, or South Kanara in 1862 because of its closer trade connection with Bombay. It comprises a belt of country of great variety and richness of scenery with an extreme length of about 110 miles from north to south, a varying breadth of 10 to 60 miles and a total area of 3,910 square miles. Towards the south-west it is bounded by the Arabian Sea, on the north-west by the Portuguese frontier and seaboard territory of Goa, on the north and east by the Belgaum and Dharwar districts of the Bombay Presidency, and on the south-east and south by the State of Mysore and a small portion of the Presidency of Madras. There being no direct railway communication, the most convenient way of approach is by steamer from Bombay to Karwar.

Before proceeding to describe the actual fruit, spice and paddy growing tracts, it would be better to give a general idea of the aspect of the interior which is considered the most picturesque part of the Bombay Presidency.

Aspect.—Extending north and south in the line of the Western Ghâts—an irregular chain of central hills of nearly 2,000 feet altitude known as the Sahyadris—divide the district into two main regions :—

1. A lowland plain and coast tract ;

2. An upland plateau and jungle tract—ordinarily distinguished as: 'below-ghats' and 'above-ghats' respectively.

Sloping from the Sahyadris to the west, are several smaller hill-ranges with numerous isolated spurs. All are densely clothed with magnificent and valuable forest and abound with big game—tiger, panther, wild boar, wild deer (sambhar), etc. Rising in the north and east of the interior, several broad rivers traverse the upland plateau for many miles before hurling themselves in narrow rocky channels over the rugged granite cliffs of the Sahyadris—producing most glorious water-falls. Continuing on their courses through the valleys situated between the westerly-sloping hill ranges, they eventually form extensive winding lagoons which enable small craft to ply to and fro with cargoes of fruit, spices, paddy, timber and general produce.

In the month of May, when the rose, purple and lilac flowers of the "taman" (*Lagerstrœmia reginæ*) are in full bloom on the hill slopes, it is indeed most beautiful to sail up one of those estuaries,—the waters glistening in the sunshine or reflecting the deep blue of the sky and the fruit gardens on either side, with their brick-red soil and long avenues of bright green "arching" plantains and stately coconut palms, surmounted by the towering wooded heights beyond.

Fruit Gardens.—Below-ghats, the best fruit gardens are situated along the banks of the rivers and on the coast land near the base of the hill slopes, while, above-ghats on the north-western side—nestling in valleys amongst the hills and shrouded in trees—are the famous betel-nut (supari), pepper and spice gardens of Kanara with innumerable and extensive plantain, orange and coconut groves.

The chief kinds of fruit grown and exported are :

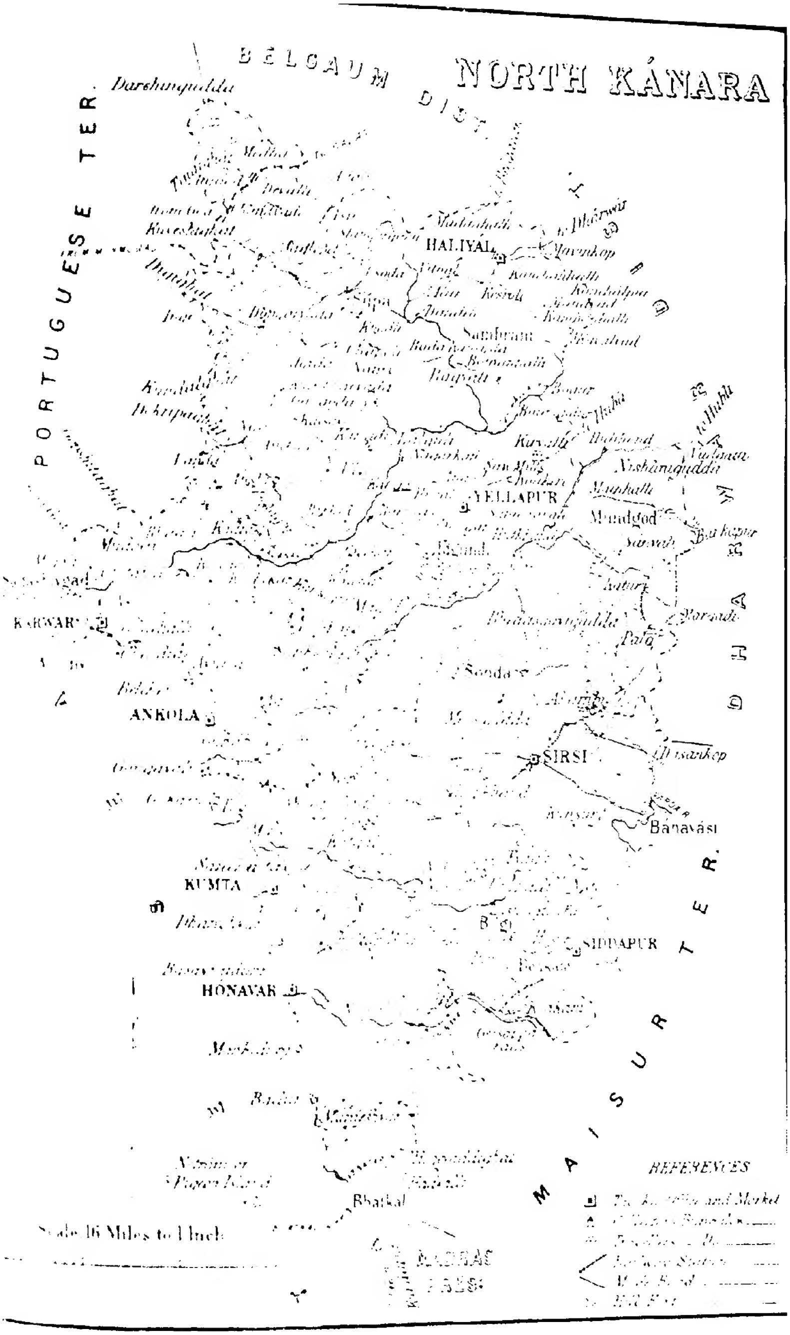
Mango (*Mangifera indica, Linn.*—varieties).

Jack fruit (*Artocarpus integrifolia, Linn.*—vars.).

Cashew nut (*Anacardium occidentale, Linn.*—vars.).

Coconut (*Cocos nucifera*—vars.).

Plantain (*Musa sapientum and M. paradisiaca*—vars.).


NORTH KÁNARA
BELGAUM DIST.
PORTUGUESE TER.
MAISUR TER.
Darshanqudda
HALIYAL
Sambrani
YELLAPUR
Mundgod
KARWAR
ANKOLA
SIRSI
Banavási
KUMTA
SIDDAPUR
HONAVAR
Bhatkal
REFERENCES
Scale 16 Miles to 1 Inch

Lime (*Citrus medica, Linn.*)—vars. : *limetta* (sweet lime) ; *acida* (sour lime) ; *limonum* (lemon).

Orange (*Citrus aurantium, Linn.*)—vars. : "santra" (round, sweet) ; "ladu" (balloon-shaped, sweet) : "bigaradia" (sour).

Pomelo (*Citrus decumana, Linn.*) vars. : (1) white pulp. (2) red pulp.

Guava (*Psidium guyava, Linn.*) vars : *pomiferum* (round, red pulp) ; and *pyriferum* (pear-shaped, white pulp.)

Pomegranate (*Punica granatum, Linn.*)

Custard apple (*Anona squamosa, Linn.*)

The following are grown to a small extent but not exported :

Bullock's heart (*Anona reticulata, Linn.*).
Fig (*Ficus carica, Linn.* vars.).
Tamarind (*Tamarindus indica*).
Papaya (*Carica papaya, Linn.* vars.).
Pineapple (*Ananas sativa, Linn.*).
Rose apple (*Eugenia jambosa*).
Jambool (*Syzygium jambolanum*)
Bor or Ber (*Zizyphus jujuba, Lamk*).
Kumrak (*Averrhoa carambola, Linn.*).
Bilimbi (*Averrhoa bilimbi*).
Belgaum walnut (*Aleurites moluccana*).
Indian walnut (*Terminalia catappa*).

The principal sweet mango varieties are grafts from the famous Goa mangoes, and include the following, arranged in order of superiority :

1. "Fernandin :" 2. "Ishad" ("Kala" and "Ujla" :) 3 "Kariyel :" 4. "Mushrad :" 5. "Aphoos" or "Alphonse."

The trees generally come into bearing about the 5th or 6th year after planting, but are not full-grown till 15 years old. The average yield of a full-grown tree is about 1,000 fruits, weighing from 2—3 lbs. each. The "Fernandin" variety is oval in shape, has a reddish bloom towards the base and possesses the best keeping properties. The garden price is Rs. 2 to Rs. 3 per 100. "Ishad" is round in shape, sweeter and more juicy

than "Fernandin," "Kala" having black and "Ujla" white spots or marks when fully ripe. It fetches Re. 1-8 to Rs. 2 per 100; the others, though larger in size and containing smaller "stones," are inferior in point of flavour. The usual price is from Re. 1 per 100. It is generally held that the later the ripening period the better the mango variety.

Of sour mango varieties, the best are :—

1. "Gaonthi" or "Chalti;" 2. "Appe mavu"; 3. "Jirge mavu;" 4. "Muge mavu"; 5. "Picha mavu."

"Gaonthi" is the most favoured variety being grown in every "compound." The average yield of a full-grown tree is about 1,500 fruits which sell at the rate of annas 12 per 100. "Appe" only grows by the side of "nallas" in the more hilly tracts. "Jirge" is a fine variety, "Muge" coarse, and "Picha" rather "stringy." Large consignments of these sour mangoes are shipped to England for the making of pickles and chutney, as well as being used locally for the same purpose. At Mulki near Kumta, and Bhatkal in the south, the best specimens of mango and jackfruit are raised. Jackfruit, in fact, grows so prolifically that it is fed to cattle as fodder. The chief varieties are :—1. "Bokke or Barko;" 2. "Chakki," "Tiiwa" or "Ambli;" 3. "Nirhalsu;" 4. "Berihalsu." The last two are about the size of a full-grown coconut and are exclusively used, when raw, as vegetables. "Berihalsu" is so named from the fruit being borne near the roots. "Chakki" is more juicy, softer, sweeter and more easily digested than "Bokke," but lacks the flavour. The average yield of a full-grown and well-nourished tree is about [illegible] fruits. "Bokke" and "Chakki" are sold by the gardeners at Rs. 3 per 100; "Nirihalsu" and "Berihalsu" at annas 10 per 100.

As regards coconuts, the finest flavoured ones are grown along the coast, while those at Keelagadda near Yellapur, above-ghats, are noted for their extremely large size, quantity of "milk" and percentage of oil. The prevailing practice above ghats is to grow "supari" and coconut palms together and below-ghats plantains and coconuts. The average number of palms per acre in a first class coconut garden is about 200. They

are invariably planted in alternate rows and spaced 12 feet apart to permit of ring irrigation. Black salt-mud from the river mouths is the chief fertiliser used. At Ankola and Kumta, on the coast, a properly tended coconut palm gives a yield of about 50 to 100 nuts a year, while at Kodlagadda the yield is 60 to 120 nuts a year, and the price obtained is respectively Rs. 4 and Rs. 3-8 per 100. The average nett profit from an acre of first class coconut garden both above and below ghats is calculated to be Rs. 200, the extra profit from the increase in yield above-ghats being consumed by the greater expense of hired labour.

At Amdoli and Bellikerri (9 miles from Karwar), the finest cashewnuts are cultivated. There are two varieties: 1. Yellow; 2. Red. The average yield per tree is about 600 fruits, weighing 6 lbs., and worth from 6—8 annas. A sandy soil is best suited to their growth.

In Yellapur taluka above-ghats (2,000 feet altitude) limes, lemons, oranges and pomelos are extensively grown along with the other less important fruits mentioned in the list above. Sweet oranges are grown in first class gardens only. The "santra" variety is spherical in shape and, though small, weighs about 7 ounces, while the "ladu" weighs about 5 ounces and is recognised by a papilla at the base next the stalk giving the fruit a characteristic balloon-like appearance. The rind of both is moderately smooth, thin and loose, the pulp dark-coloured, exceedingly juicy and of excellent flavour. The prices are usually Re. 1 and annas 8 per 100. The "bigaradia" or sour oranges locally known as "Hi-hannu," are largely grown and used in the preparation of chutney. The average yield per tree is about 150 fruits and the wholesale prices realised are annas 8 and annas 6 per 100 according to size. The thin-skinned red pomelos measure 7 inches in diameter, weigh about 4 lbs., and along with mangoes are considered by some the finest fruits in India. The selling price is Rs. 4-8 and Rs. 3 per 100.

Among plantains, the best flavoured are grown along the coast. The chief varieties are: 1. "Rasbale;" 2. "Nirbale;" 3. "Mithabale;" 4. "Karibale;" 5. "Mysorebale;"

6. "Chandrabale;" and 7. "Anabale." "Rasbale" ranks as best. It is about 4½ inches long, sweet-scented, of fine flavour and very soft and juicy. It is particularly wholesome and fetches at the gardens annas 6 to annas 10 per 100. "Nirbale" and "Mithabale" varieties measure about 3 or 4 inches in length. They are narrow, thin-skinned, very sweet and of excellent flavour. The garden price is annas 4 to annas 6 per 100. "Karibale" or "Saldati" is quite semi-circular in shape with a very thick skin which turns black when fully ripe. Within the pulp is pure white, fine-flavoured and very refreshing to eat, but if indulged in too freely is said to produce fever. Price, annas 5 per 100. "Chandrabale," as its name implies, is red skinned, likewise also "Mysorebale." The former measures from 6—8 inches long and is moderately thick or coarse. The latter variety is about half the size, slightly tart and contains many seeds. The average yield per tree of these two varieties is about 15 or 20 fruits and the price annas 6 and annas 3 per 100 respectively. "Anabale" or "Bhainsi" is the largest of all and measures about 1 foot long. It is thick and coarse, usually allowed to become quite dry by placing in the sun and then used in fruit curry. The selling price is annas 10 per 100. The red or "kagdali" soil is regarded as the best of all for plantain growing. An acre of first class garden land is capable of containing 1,200 shoots. Each shoot bears annually only one bunch called "ghadaya," containing about 100 fruits. The best plantains are cut green and allowed to ripen slowly and uniformly by hanging up in a cool dark place. This practice causes the fruit to remain juicy and soft, possess a fine colour and fetch a better price, besides avoiding destruction by monkeys, squirrels and birds.

The Tamarind, Kumrak and Bilimbi fruits are used in preparing *deshi* chutney, while the remainder, when ripe, find a place in the daily menu of those who can afford luxuries. The annual return from an acre of a first class fruit garden is estimated at Rs. 500 and the expenses of upkeep are put at about Rs. 200, leaving a profit of Rs. 300.

PLATE XLIV.

[illegible] River Scene, North Kanara.

Entrance to a Cocoanut and Supari Garden, North Kanara.

Spice Gardens. In the spice gardens, besides the betel palm "supari" (*Areca catechu*) the spices grown are :—

Pepper (*Piper nigrum Linn.* vars.).
Pan (*Piper betel Linn.*) grown for leaf only.
Cardamoms (*Elettaria cardamomum*).
Cloves (*Eugenia caryophyllata*).
Nutmeg (*Myristica fragrans*).
Ginger (*Zingiber officinale*).
Cinnamon (*Cinnamomum zeylanicum*).
Chillies (*Capsicum frutescens*).

The cultivation of "supari" is confined to the above-ghat talukas of Siddapur, Sirsi and Yellapur. In laying out a spice garden, the ground is first of all formed into beds 20 ft. wide by trenches which serve as drainage channels. Twelve feet apart and two feet from the edge of the drains, plantain suckers are set. Raised irrigation channels are formed down the middle of each bed and the plantains watered every 15 days during the dry weather. After two years young betel palms are transplanted into pits dug mid-way between the plantains. The plantains not only afford shelter but the returns from disposing of the fruit (about Rs. 25 per acre) cover part of the initial expenditure. After the young palms have become thoroughly established, the plantain shade and catch crop is gradually removed and cardamom bushes substituted. It takes about 13 years for a betel palm to come into full bearing. One acre of first class spice garden land containing about 500 to 800 palms gives an average annual yield of 3 khandis (60 maunds or 15 cwts.) of cleaned nuts. The price of the nuts varies each season according to quality of crop and quantity available. In one khandi (20 maunds or 5 cwts.) 5 grades of nuts are usually distinguished and, if cut at the proper time, the proportion and price is as follows :—

5 maunds	"Api"	Rs. 8 per maund ...	Rs 40
7 ,,	"Chikni"	Rs. 5 ,, ...	,, 35
6 ,,	"Betti"	Rs. 4 ,, ...	,, 24
1 ,,	"Gota"	Rs. 2 ,, ...	,, 2
1 ,,	"Chali"	Rs. 2 ,, ...	,, 2
		Total	Rs. 103

One acre, therefore, gives an approximate return of Rs. 310. The pepper "vines" are of three varieties, each differing in yield and manner of growth, but the quality is practically the same in all. The "kari-malisaru" variety, for example, gives the best yield, but will only grow in what is known as "kagdali" soil (a red mould), while the other two "sambar" and "arsina murtiga" will only grow in the khaki soapy (talc) clay soil, called "arsina munnu". The "vines" are trained up the stems of the betel palms. Cardamom seedlings are planted in the intervening spaces—about 300 going to the acre. The same treatment in the way of manures, watering, etc., serves for all. After six years, the "vines" give, on an average, an outturn of 15 to 18 maunds ($3\frac{3}{4}$ to $4\frac{1}{2}$ cwts.) of "pepper-corns" per acre—value, at Rs. 5-8 per maund, Rs. 82-8 and Rs. 99 respectively, and after three years, the cardamoms give a return of 1 maund (28lbs.) per acre—value Rs. 48. What is reckoned the best "pan" (Piper betel) comes from Hosakuli, 3 miles from Kumta. The "Pan" or betel vine thrives best when trained on mango trees. After three years, an acre of garden containing 500 vines gives an outturn of 40,000 leaves per annum, worth about Rs. 40. A complete spice garden in full bearing is calculated to bring in an annual return of at least Rs. 400 per acre, but the expenses of upkeep, harvesting, etc., being exceptionally heavy (Rs. 280—Rs. 300), there is a clear profit of only Rs. 100—120 per acre. These gardens are entirely in the hands of Havig Brahmins—a very intelligent and industrious class of men. The most of the fruits, nuts, and spices are regularly bought by traders and sent to Bombay, Hubli and Dharwar markets. Coconut and other oils are extracted and manufactured chiefly in the towns of Hubli and Dharwar.

Paddy Lands.—The paddy-growing tracts are confined to the below-ghat plain and coast tract and to the above ghat clearings and open plateau. Paddy is universally grown during the rains, the richer lands yielding a "waingan" or spring crop afterwards. The soil and climatic conditions above- and below ghats differing considerably, a short description of each might be

interesting as well as explanatory of the methods of sowing, cultivation, etc., adopted, but more especially to show how the continuous influence of a particular environment during an unknown period of time seems to have determined resultant types of paddy best adapted to those conditions.

Below-ghat Soil.—The low land plain and coast tract extends right along by the seashore for 70 miles and inland about 20 miles to the base of the Sahyadri range. It comprises detached areas of arable land mostly terraced since the ground has a natural slope seawards and the terracing not only checks the flow of water during the rains, but prevents the particles of fertile soil from the hill sides being washed away. "Bandhs" are erected where necessary to keep out the flood waters of the rivers or the sea at high tide and to regulate the depth of water in each area.

The cultivated soil of these flats consists, for the most part of a reddish alluvial clay, locally known as "betta" and has apparently originated from the laterite or iron claystone (basic lava) of the hills near the coast. If this clay is not constantly worked and heavily dressed with green manure, it stiffens into clods and stifles growth. Adjacent to the forest, as well as at the upper ends of the valleys, the soil differs in texture, being more of the nature of a red mould with a large proportion of vegetable and other organic matter and an abundance of white mica particles—probably derived from the gneiss and micaceous schists which underlie the laterite rock. This particular soil is called "kagdali" and forms the fruit garden soil already referred to.

At the lower ends of the valleys and bordered by the rivers are the so-called "Kar" lands, inundated during the monsoon with brackish water, and after the floods have subsided, a fine rich alluvium is deposited called "bailu" upon which "waingan" or spring paddy is grown under irrigation. Wherever this deposit abuts upon the shore, it becomes overlaid or mixed with drift sand and then receives the name "pullan."

The sandy soil of the coast called "majalu" is naturally poor and much broken up by salt water creeks, but all the same

it is able to produce a crop of paddy and afterwards a crop of first-rate vegetables, if watered from temporary wells dug close by for the purpose. The vegetables include a large number of varieties of Cucumbers, Gourds, Melons, Brinjals, Tomatoes, Sweet Potatoes, Yams, Onions, Garlic, etc., "tatti" houses and frames being erected for growing the first five of these.

In addition, there are at certain coast places, *e.g.*, Kumta, Madangeri, Molki, etc., large areas of reclaimed shore, called "gazini," composed of black mud with varying quantities of salt, decaying oyster shells and other organic matter. The amount of salt present determines the particular variety of salt-paddy that can be grown, but the presence of too much shell-lime is detrimental to the growth of all varieties.

Still another type of soil known as "Makki" is met with, in patches, at varying altitudes. It is stony, coarse and porous, being simply the weathered crust of underlying murum and varies in depth from a few inches. (Compare the soil of the "khushki" or dry-crop land above-ghats.)

Thus, below-ghats there exist seven different types of soil, each and all of which are peculiarly suited to the growth of particular varieties of paddy.

Above-ghat Soil.—Above-ghats, the land, as already mentioned, is a more or less level plateau covered with extensive jungle. In former times the Kunbi tribes burned or cut down portions of the jungle and sowed the land with "ragi" (*Eleusine coracana*) or "bajri" (*Pennisetum typhoideum*)—generally known as "kumri" or "jhum" cultivation. These clearings now form many of the paddy and dry-crop lands. The types of soil range from a khaki-coloured and extremely moist soapy (talc) clay called "arsina mannu" to a ferruginous clay-loam largely mixed with milky quartz and ironstone gravel, shading off gradually into the black cotton soil as the Hubli and Dharwar Districts in the north-east are approached.

The soapy clay, formed from the outcropping talc and micaceous schists, when mixed with liberal supplies of well-rotted leaf manure and cowdung, forms the soil of the betelnut and spice

PLATE XLV.

A. G. L. Typical Supari and Spice Garden above Ghats, North Kanara.

Typical Bird's-eye View of Fruit Gardens and Paddy Lands below Ghats, North Kanara.

gardens at Siddapur, Sirsi and Yellapur on the western side, while the richer loam constitutes the soil of the fruit gardens and the basis of that in the lower lying paddy lands, from Siddapur in the south as far north as Mundgod and Yellapur talukas.

The soil proper of these paddy or wet lands called "tari," contains an abundance of decaying vegetable matter, receiving, as it regularly does, the rubbish and silt washed down by the heavy rains from the forest and garden lands above. On the higher levels, notably around Hubli and Dharwar, the "khushki" land in which the dry crops flourish (Millets, Sesamum, Safflower, etc.) is a course red gravel containing varying amounts of organic matter, while the soil of Haliyal taluka, in the extreme north, forms a distinct contrast to all the others, being a bluish-green clay derived from the chlorite slate and other transition rocks which form an outstanding feature of the geology of that district.

For irrigation supplies the people are entirely dependent upon a few mountain streams, wells, or underground springs, conducted into huge, stone-built tanks. The soil being always moist, however, some of the finer and better varieties of paddy are grown, while, in the spice and fruit gardens, draining has to be carefully attended to during the rains. The paddy lands are terraced wherever the ground slopes, "bundhs" being also formed to retain the monsoon waters and the overflow from garden lands. As the fields, and more especially the orchards, are often ravaged by wild boars and deer from the jungle, high, strong, wooden fences bound together with barbed wire form a barrier all round with sometimes an additional hedge of live thorn bushes, such as Prickly pear (*Opuntia nigricans*), Milk bush (*Euphorbia tirucalli*), Mysore thorn (*Caesalpinia sepiaria*), etc.

A broad ditch, serving at times as an irrigation or drainage channel, surrounds the whole garden, very often with four or five alternating rows of coconut palms on either side.

En passant, the village of Ekambi, about ten miles from Sirsi, is named after what is described as "the largest and most

magnificent specimen of wild mango tree in India" to be seen growing on the outskirts of the jungle close by.

Climate.—One of the most notable features in the climate of North Kanara is its equable temperature throughout the year. In the coast plain the temperature varies from 84·3° F. in May to 75·9° F. in January and averages 80·1° F.; while above-ghats it varies from 82·3° F. in April to 72·7° F. in January and averages 76·2° F. The normal humidity below-ghats is 74° and above-ghats 57°. As regards rainfall, the returns show that this is much higher on the coast than in the uplands, and also varies north and south in these divisions. On the north-west coast the average annual rainfall is 116·6 inches and on the south-west 139·85 inches; while in the northern uplands it is 47·8 inches, and in the southern 95·62 inches. Local position has considerable influence—distance from the sea on one hand and from the crest of the Sahyadris on the other are the chief points determining the rainfall. In the coast tracts in June, for example, the clouds are driven against the western slopes of the Sahyadris and the country is flooded. In the uplands, beginning early in May, intermittent showers fall, the clouds being apparently attracted to the wooded heights, while further east they very often float far overhead without breaking.

Paddy Sowing.—Below-ghats paddy is either broadcasted with dry seed ("bere bhatta") or with sprouted seed ("mul bhatta") or else transplanted ("neti bhatta") depending on the nature of the land. The "bailu," "pullan" and "kar" lands are usually transplanted; the "gazni," "majalu" and "betta" lands are sown with germinated seed, while the "makki" lands are broadcasted in the ordinary way. The outturn, quality and consistency of grain follow this same order. The using of germinated grains is economical, in that it saves a quarter of the sowing seed, and ensures a more even as well as an actual crop should the seed have been obtained offhand; moreover, it seems the only possible way of sowing in, or dealing with, the extremely soft, sticky and boglike clay or fertile mud after the rains have set in

Husked grain - red

Patni (yellow ...) Kumta

North Kanara

Parmal sal or Ambemyar (yellow brown) Haliyal N Kanara

Husked grain white

Above-ghats, on the other hand, the paddy is nearly all drilled ("kurige bhatta"), partly owing to the lower and less certain rainfall, but more particularly on account of scarcity and price of hired labour, since most of the farm coolies migrate to the below-ghat villages for the rainy season. Hence it is more profitable to drill the paddy whenever the premonsoon showers break; all that remains to be done during the rains being one or two weedings, generally carried out by the cultivator and his family. The migration of the people is due to the malarious nature of the villages during the latter half of the rains. The proximity of the jungle shuts off air currents and causes the atmosphere to be close, steamy and unwholesome, while the stagnant water forms a favourable breeding ground for the dreaded "anopheles" mosquito. Food stuffs, clothes, etc. are more expensive, having to be brought by road either from the nearest sea-port, Kumta 40 miles off, or the railway at Hubli—a distance of 60 miles.

Paddy Manures.—The question of manures for paddy is a delicate one in Kanara. Below-ghats all the ryots assert that iron clay makes poor soil, and therefore the one and only manure suitable for the growing of paddy is "soppu," *i.e.*, a mixture of green leaves and cowdung. In the olden days, before the Forest Department was in existence, the people used to go to the forests and cut down as much green leaf as they required. This was then spread on the floors of their cattle sheds and, after three or four days, removed and placed in a heap outside. Later it was carried to the fields, spread-over and ploughed-in. The continual and promiscuous cutting of forest trees had to be put a stop to, as valuable timber trees were being ruthlessly destroyed and, what was even worse, whole hill-sides were being denuded, with the not unnatural result that when the heavy rains fell, all the soil was washed away, leaving only bare rock.

The contour and climatic conditions were thus rapidly undergoing a change; hence it necessitated strict rules being enforced by the Forest Department. This procedure naturally created great discontent amongst the ryots but recently more liberal

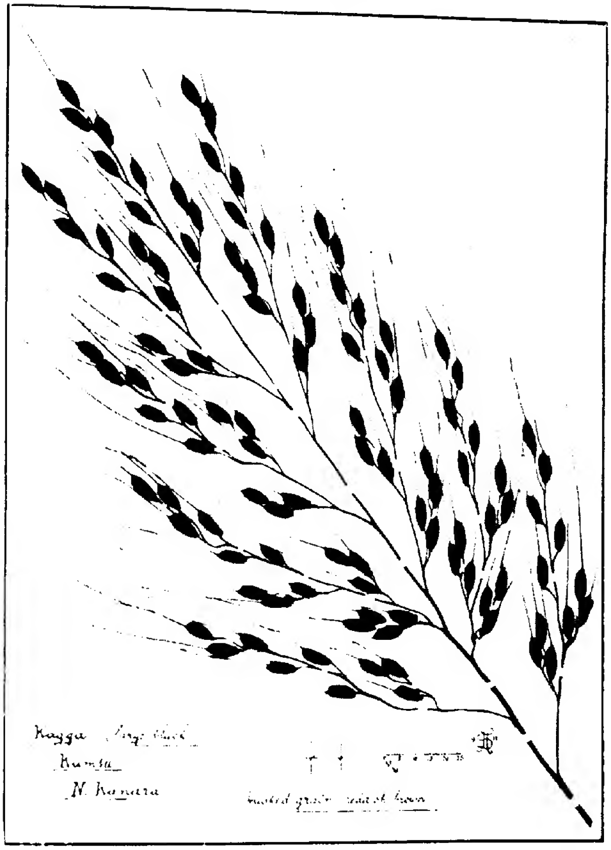
privileges have been conceded to them. If the growing of green manure crops were adopted, the ryots might be to a certain extent independent of the Forest Department

Above-ghats, the soil, being of a richer and less clayey (*i.e.*, more open) nature, there is not the same necessity for green manuring. Cowdung, dead leaves, paddy-straw, paddy-husk and wood-ashes mixed together are ploughed in, or this same mixture is burned on the ground first of all.

The black cotton soil of Dharwar District is not considered so suitable for paddy cultivation, and the rainfall being somewhat precarious forms a limit in this direction. Tank irrigation is, however, resorted to in certain places. Generally speaking, it may be said that in North Kanara paddy is grown in every type of soil, provided the rainfall is not less than 45 to 50 inches. The number of types of paddy grown, each possessing some characteristic feature, is very large indeed and forms the subject of an investigation at the present time. This short survey, however, makes it obvious that the paddy plant possesses a remarkably ready power of adapting itself to a wide range of environmental conditions when aided, to a greater or less extent, by artificial means. As in most plants, this adaptation is indicated outwardly in a specific manner. The higher and drier land paddies are short and weak stemmed, with coarse, bristly or awned grains, ripening early and giving a varying yield comparable with the respective fertility of the soil. The straw of these varieties makes excellent fodder, being soft, juicy and low in indigestible cellulose content. ("Patni"—Plate XLVI). The low-lying, rich, moist or flooded lands produce the long, thick-stemmed varieties, giving small, scented, smooth, awnless grains, late ripening and high in yields. ("Parmal sal"—Plate XLVI). The salt paddies, on the other hand, are generally long and thick-stemmed, with huge, coarse, awned or awnless grains, giving a high outturn and ripening early: but the taste of the grain is musty and rather unpleasant. ("Kagga"—Plate XLVII).

Yellow, brown, red, black, etc., types of husk (both glumes and pales) occur in all, with either white or red seed coats

PLATE XLVII.



A. J. I.

(pericarps). As regards etymology of nomenclature, in the majority of cases the characteristic shape, size, colour, habit, taste, etc., of grain ; its similarity to other flowers, seeds, fruits, tubers, etc., in respect of scent, shape, appearance, etc.; association with particular places and soils, as well as personages ; methods of sowing, cultivation, etc., have all given rise to a vocabulary of names which at first sight appears rather bulky, but on investigation proves to be largely composed of synonyms from the various dialects—Marathi, Hindustani, Sanskrit, Kanarese and Tamil. Even two neighbouring villages have different names for the same variety. Any attempt at a practical classification, after pure cultures have been obtained, seems necessarily based upon such like considerations.

Note.—The photographs in Plates XLIV and XLV illustrating this article were kindly supplied by Mr. F. J. Varley formerly Collector of North Kanara, and Mr. G. Laird MacGregor, Collector of Dharwar.

A SIMPLE HONEY-EXTRACTOR.

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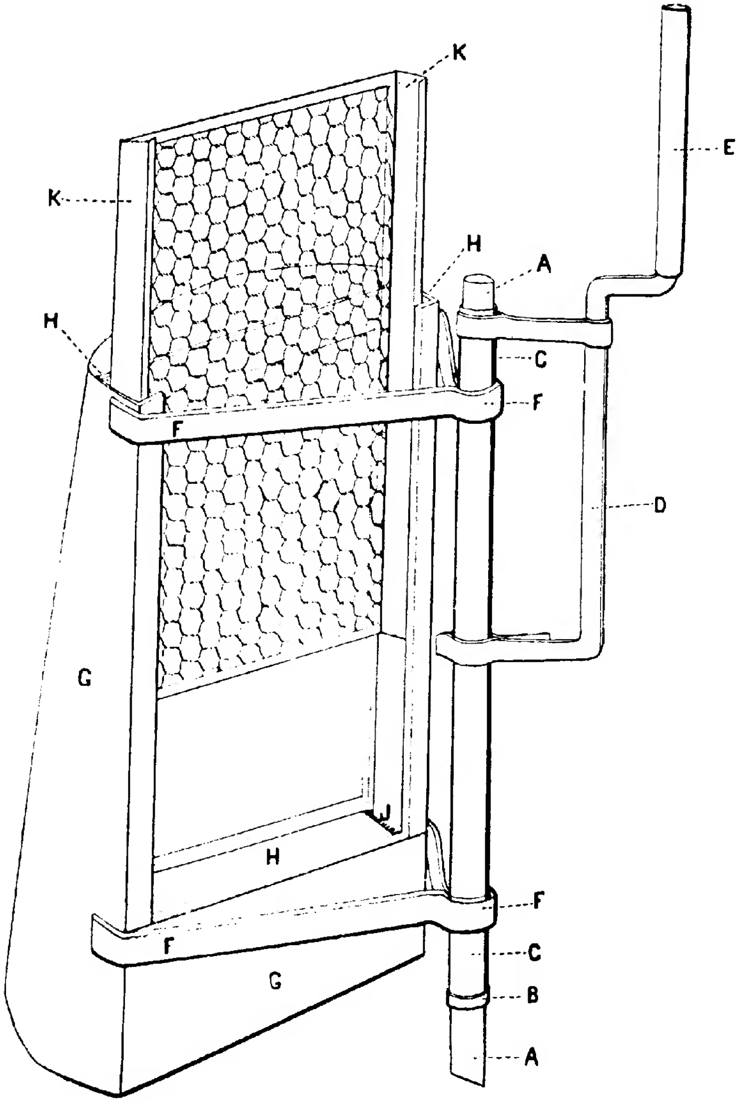
The recent want of an extractor to remove surplus honey from the bee-hives at Pusa led us to construct, with the help of the Farm blacksmith, a simple machine which proved quite effective, and of which a description is given here as it may prove equally useful to other bee-keepers in India, who own only a small number of hives, though it is unsuitable for a large apiary as only one comb can be operated on at a time. Its construction, for which no originality is claimed, is quite simple and well within the reach of any ordinary skilled blacksmith or mechanic.

Like all similar machines, its action depends on the principle of centrifugal force. We all know that if we tie a weight on to a string and whirl it round there is a perceptible pull on the string, and that, if we suddenly release the string, the weight will fly off at a tangent. This is the principle we employ. By revolving the frame, the honey is thrown out of the cells without damaging the comb, which is afterwards given back to the bees to clean and refill. The honey is in fact thrown out just like water from a trundled mop.

The extractor revolves around a long, round, iron pin or stake (A A), sharp-pointed at the lower end, which is thrust firmly into the ground, and provided with a narrow metal collar (B) on which rests the weight of the moving parts. These are suspended from a hollow iron tube (C), which fits over the central pin (A) and rests on the collar (B). To one side of (C) is riveted the



A Simple Honey-Extractor.

(For explanation of lettering see text.)

handle (D), the top of which is loosely covered with a piece of bamboo (E). To the opposite side of the tube (C) are riveted two iron V-shaped arms (F) which support the honey-can (G). This latter may be made of stout tin-plate—the ordinary kerosene tin of commerce provides suitable material—but *galvanised iron must not be used*: it must of course be closed at the bottom and on the outer side, which is rounded, but the inner side (*i. e.*, the side nearest the tube C) need not be closed above the lower arm of the supporting bracket (F), as shown in the sketch. Inside the honey-can is fitted a wooden framework (H) to receive the cage (K) in which is placed the frame of honeycomb (not shown in the figure). This wooden frame is, of course, open at the top and slotted at each lower angle (J) to take the projecting end of the bar-frame. The cage (K) is made of tin and may be open on one side, as shown in the sketch. The narrow ends slide up and down in the frame (H) and the outer side is made of large-meshed wire-netting: as noted above, galvanized wire-netting must not be used; if nothing better is obtainable, the galvanizing must be burnt off.

The method of use is quite simple. The frame of comb is fitted into the tin cage (K) and the whole slid into the wooden frame (H). The whole process is explained below.

The dimensions of the machine will be governed primarily by the size of the comb-frames, but, to get the best results, the outer surface of the comb should, during extraction, be placed six inches from the centre of the spindle around which it revolves. The standard size of frame, to which all bee-keepers should conform to secure uniformity, is 14 inches long by $8\frac{1}{2}$ inches deep (outside measurements), the top bar being 17 inches long, thus forming a lug at either end for convenience of handling and for suspending the frames in the hives.

Assuming that the combs are full of honey and at least two-thirds sealed over—the longer the honey remains in the hive, the more perfect the ripening—they should be removed and the bees gently shaken or brushed off. It is assumed that the combs to be extracted contain nothing but honey, and that no

brood (immature bees) is contained in them. This end can easily be attained by the use of a sheet of queen-excluding zinc between the brood-chamber (the lowest section of the hive) and the supers in which honey is to be stored.

The honey-cells, being capped over with wax, will require to be opened up, and this is easily done by slicing off the capping with a large flat-bladed knife. Almost any large flat knife may be used, an ordinary breadknife answering admirably. Whatever form of knife is made use of, it must first be dipped in hot water and wiped dry. To uncap, grasp a frame firmly by one end of the top bar, resting the other end on a dish so that the comb is inclined outwards. Then take the warm knife and cut upwards, shaving off the cappings which will fall in the dish. Reverse the comb and uncap the other side in a similar way.

The comb is now ready for extraction and may be slid into the cage which is itself slid into the frame of the machine and the handle turned slowly. Experience will soon show the speed at which the machine should revolve to throw out the honey; this will vary with the honey itself, but in any case the *minimum* speed necessary is to be used. In the case of new or unwired combs, it is best to extract only about half the honey in the first side, then reverse and extract the whole of the honey in the other side, then again reverse and finish extracting the first side. By proceeding in this way, we avoid some of the pressure exerted by the full cells on the inner surface of the comb upon the empty outer side.

The honey will all collect at the bottom of the can of the extractor, whence it may be poured into any convenient empty vessel. It will contain small particles of wax and other impurities and will therefore lack a proper brightness of appearance. To remedy this, the honey should be strained through a piece of clean cloth or flannel freshly wrung out of hot water: it will run through very slowly of itself, but by twisting the cloth it may be made to strain through quite rapidly. The honey is now ready to be put away in jars or other receptacles in which it is to be stored.

There are three main rules to be followed when extracting honey. Firstly, never revolve the machine more rapidly than is absolutely necessary, or there is great liability of breaking the combs. Secondly, never extract honey in any place frequented by bees: otherwise, the presence of honey will attract bees and they will start fighting and robbing and causing a disturbance which will be difficult to stop. For the same reason, great care should be taken never to spill honey about anywhere near the hives. Thirdly, do not extract honey from comb containing immature bees, or the brood will be killed and the honey spoilt.

After the honey has been extracted, the empty frames should be given back to the bees to clean up and refill, and the Extractor thoroughly cleaned with hot water and carefully dried.

It is not generally realised what a wasteful practice it is to simply express honey from the comb by squeezing it out from the wax. Wax is a very expensive product for the bees. Experiments have shown that it takes from 10 to 21 lbs. of honey (the quantity varies under different circumstances) to produce 1 lb. of wax and we shall not be far wrong in taking 15 lbs. as an average figure; that is to say, the bees require to consume 15 lbs. weight of honey to make up for the enormous wear and tear of their tissues caused by the secretion of a single pound-weight of wax. The great advantages of an extractor are therefore obvious: not only does it economise honey by preserving for future use all the wax except a thin layer of capping, but it saves the bees a great waste of time in building up new cells—two points which will be found to have a very important bearing on the amount of honey produced by a hive in the year.

A brief summary of what is being done at Pusa in the way of bee-keeping will probably save a great deal of correspondence. We have in India three common kinds of wild honey-bees :—

(i) *Apis dorsata*, a very large species which lives in the hills and the damper regions of the plains, and makes a single

large comb which may measure four or five feet across and which is usually hung under the horizontal branch of a tree or amongst rocks. This bee does not occur at Pusa and we have not experimented with it, but it has the reputation of being very fierce and untameable and its habit of building only a single comb makes it difficult to work with.

(ii) *Apis indica*, a species slightly smaller than the European honey-bee but very similar to it. This builds several parallel combs, generally in a hollow tree, and is kept in a state of semi-cultivation in some places, notably in Assam, boxes being placed for the swarms of wild bees to occupy. This bee has been tried at Pusa, but we have not found it at all satisfactory as it seems quite unable to withstand attacks of wax-moths, which tunnel the combs to such an extent that the bees desert them in disgust.

(iii) *Apis florea*, a very small bee which hangs its small single comb in trees and bushes and on buildings. The honey is excellent, but the whole comb is so small as not to repay cultivation, especially as this bee also suffers badly from wax-moths and is therefore difficult to keep.

In the hills, a variety of the European bee is kept at Simla and other places, but this bee does not do well in the plains—at least, those which were brought to Pusa proved a total failure.

We have been experimenting at Pusa with a new kind of bee which we hope will do well in the plains of India; up to the present it has proved a success, but we shall require a great deal more experience of it under hot weather conditions before we shall feel justified in recommending it to inquirers.

At the present time there is no race of bees which we can recommend to would-be bee-keepers in the plains of India.

Of the native races, *Apis indica* seems to offer the best chance of success, but the bees should be kept in proper frame-hives and this means that everything will have to be done on a scale different from the standard adopted for the English honey-bee; for example, the combs will have to be differently spaced and the foundation and queen-excluders will require to be of different sizes, necessitating special machinery to make them.

In any case, bee-keeping can only be recommended as a supplementary source of income and not as a sole means of livelihood. Anyone who contemplates embarking in this pursuit is strongly recommended to do so on a small scale only; two or three hives are sufficient to start with, and this number may be increased as experience is gained

THE WAX-MOTH.

By T. BAINBRIGGE FLETCHER, R.N., F.E.S., F.Z.S.,

Officiating Imperial Entomologist.

THE Wax-Moth (*Galleria mellonella*) seems to have been originally an inhabitant of the Euro-Asiatic continent and of Africa north of the Sahara, but is now spread by human agency over practically the whole world. If not an original native of North America, it was doubtless taken there with some of the earliest hives of bees imported from Europe. It is said to have been introduced into Australia from Europe before the year 1878, when it was recorded from Queensland, and was first noticed in New Zealand about 1904, having probably been brought in from Australia. In India and Ceylon it is common everywhere, being particularly abundant in the plains of India during the rainy season.

Throughout the whole area of its distribution, the Wax-Moth is looked upon as one of the major enemies of the apiary. In India, in districts where bees are not domesticated, it attacks the combs of the wild honey-bees to such an extent that the bees often desert their nests in disgust and swarm off to found a new one, while it is very rare to find a deserted comb which does not bear traces of the ravages of this pest.

The damage is done wholly by the caterpillar, which tunnels through the bees' combs, lining its galleries with a profuse web of silk. This presents a very characteristic appearance in the later stages of the attack, by which time the comb is often riddled with galleries and almost hidden under a layer of white silky webbing. The wax itself seems to form the sole food of the caterpillar, neither the immature bees nor the honey being eaten by it.

Life-History.

The eggs (Plate XLVIII, fig. 7) are very small, about half a millimetre (one-fiftieth of an inch) in length, with a smooth surface, and are laid by night, being deposited always in the comb, in a more or less concealed situation. They are usually laid in small clusters containing as many as forty eggs, but are sometimes deposited singly. The edges of a brood-comb seem to be preferred for oviposition by the female moth. In the Pusa Insectary broken pieces of honey-comb were supplied to the moths, and they usually laid their eggs in cells along the broken margins: in places where the walls of a cell were pressed down so as to afford a hidden corner, such corners seemed to be preferred to any other situation for oviposition. The moths are rather sluggish in the daytime and may sometimes be seen at rest then on walls, posts, etc.: in the evening they become active and flit about around the bees' combs watching for an opportunity to lay their eggs. The majority of these appear to be laid on the first night after the moth's emergence, and the short life of the moth itself (as shown in the following table) appears worthy of remark.

Details of oviposition of Wax-Moth as recorded in Pusa Insectary.

	Date of Emergence and Pairing.	Eggs. Number laid.	Eggs. Laid on night of	Male died.	Female died.
1	11th May ..	110	11th May	..	12th May.
2	7th ,, ..	97	8th ,,	10th May	9th ,,
3	9th ,, ..	*Nil*			10th ,,
4	10th ,,	158	10th May	12th May ..	11th ,,
5	11th ,,	41	11th ,, ...	12th ,, ...	12th ,,
6	8th ,,	30	8th ,,	...	11th ,,
7	11th ,,	50	11th ,,		13th ,,
		Nil	12th		
8	7th ,, ..	77	8th ,,	9th May	9th ,,

Details of oviposition of Wax-Moth as recorded in Pusa Insectary—concld.

	Date of Emergence and Pairing.	Eggs.		Male died.	Female died.
		Number laid.	Laid on night of		
9	9th May	*Nil*		......	10th May.
10	10th ,,	76	10th May	12th May ...	11th ,,
11	11th ,,	4	11th ,,	..	12th ,,
12	7th ,,	4	8th ,,	9th May ..	9th ,,
13	9th ,,	36	9th ,,		10th ,,
14	10th ,,	6	10th ,,		11th ,,
15	11th ,,	*Nil*	...	..	12th ,,
16	10th ,,	*Nil*		12th May ...	11th ,,
17	11th ,,	46	11th May ...	13th ,, ..	12th ,,

The eggs are white when first laid but turn dull and sullied before hatching, and are then exactly concolorous with the wax.

The young caterpillars escape from the egg by biting out a hole of exit; on emergence they do not eat the empty egg-shell, but immediately commence to run about very actively in search of a suitable place to tunnel into the wax of the comb. The caterpillars hatching from a cluster of eggs do not all commence to feed at the same place, but scatter over the comb, each burrowing in separately, the places of their entry being indicated by a mass of small globular fragments of wax. From these points they tunnel into the comb in all directions, feeding on the wax and lining their galleries with a profuse lining of silk in which are entangled minute blackish pellets of frass. In badly infected combs, in which there are many larvæ, the whole surface of the comb is sometimes covered with a mass of this fine webbing and there seems little doubt but that the caterpillars spin these strong silken galleries as a protection to secure themselves from the bees as they advance in their work of destruction.

The young caterpillar on emergence from the egg is about 1 millimetre ($\frac{1}{25}$th inch) long, of a dirty-whitish waxy colour,

with a yellowish head smaller than the prothorax which is the broadest segment of the body; it is slender and grub-like on account of the prominence of the thoracic (true) legs. As noted above, it burrows into the comb, particularly in the septum separating the two layers of cells, and feeds on the wax, eating neither the honey nor the immature bees which may be in the cells. Here it lives and grows until after four or five weeks it becomes full grown, when it is about 20—25 millimetres ($\frac{4}{5}$th to 1 inch) long, cylindrical, smooth except for a few short hairs, of a dirty white colour, with a red-brown head and a pale-yellow prothoracic shield mottled with brown. (Fig. 2). The grown-up caterpillars are also active, but not nearly so active as the young ones.

When full-fed the caterpillar spins a white silken cocoon either in the comb on which it has been feeding or in some corner or crack of the hive or its surroundings. The cocoon (fig. 3) is closed completely at one end, but the other open end, that towards which the head of the pupa is turned, is left except for a few loose fibres of silk. In many cases the caterpillars all spin up close together, so that the cocoons are fastened together in a solid mass: this is especially the case when a crack or corner is the site selected. The pupa (fig. 4) contained inside the cocoon is from 10 to 15 millimetres ($\frac{2}{5}$ to $\frac{3}{5}$ inch) long, yellow, and with a minutely toothed ridge running along the mid-dorsal region. On the anal extremity are four small cremastral hooks, but these do not appear to be entangled in the fibre of the cocoon as a general rule, though this was of course their original function. The empty pupal shell is left inside the cocoon on the moth's emergence.

The moth itself (figs. 5, 6) is a rather stoutly-built insect, measuring 25 to 40 millimetres (1 to $1\frac{3}{5}$ inches) across the outspread forewings which are of a reddish-brown-grey colour, lighter towards the outer edge: the hindwings are grey-brown. As is usually the case amongst moths, the females are, as a rule, larger than the males and can easily be distinguished by the shape of the outer edge of the forewing, which is straight, whilst in

males it is concave. [Compare figs. 5 (male) and 6 (female).] The moth is not seen about very often in the daytime, but may occasionally be observed at rest on walls, etc., when it sits with its wings folded into a triangle. (Fig. 1.)

The whole life-history of an individual moth covers a period of about six to eight weeks from egg to adult. The following table shows the life-history of some of the moths reared in the Pusa Insectary :—

Life-cycles of Wax-Moths in Pusa Insectary.

	Eggs laid on night of	Larva hatched.	Larva pupated.	Moth emerged.	Life-cycle in days.
1.	8th May	15th May	28th June ...	6th July ..	59
2.	9th ,,	16th ,, ...	17th ,,	25th June	47*
3.	9th ,,	16th ,,	2nd July	10th July ...	62†
4.	10th ,,	17th ,,	15th June	23rd June ...	44*
5.	10th ,,	17th ,, ..	5th July	13th July ...	64†
6.	11th ,,	18th ,,	20th June ...	29th June	49*
7.	11th ,,	18th ,, ..	5th July	13th July ...	63†
8.	29th March	5th April	3rd May	11th May ...	43

* Shortest and † longest cycles of same broods.

Remedies.

Practically nothing can be done to exterminate the moth in India owing to the colonies of wild bees, some kinds of which occur almost everywhere and provide the moth with suitable food. In the case also of bees kept in a more or less domesticated condition in walls of houses, earthenware vessels and ordinary box-hives, little can be done without practically destroying the whole comb, as it is not possible to examine the nest properly and check the damage before it has assumed unduly large proportions. In these cases it is, of course, impossible to fumigate the combs to kill the caterpillars without destroying the bees as well.

The universal prevalence of this destructive moth is one of the strongest arguments for the use of modern forms of beehives in India. The use of a bar-frame hive, in which every comb can be taken out and examined carefully, should be an absolute guarantee against any extensive damage by this pest. The golden rule of Bee-keeping, "keep every colony strong," if

carried out, will do much to mitigate the pest, for the bees themselves will generally keep the moths from the combs if their numbers are sufficient to cover all the frames; Italian bees in particular keep guard against the Wax-Moth, though the native Indian bees are apparently less vigilant. No cracks or chinks of any sort should be allowed in the hive; all such should be filled up with putty or clay. Never leave old combs or pieces of wax lying about, as such are sure to be attacked by the Wax-Moth; they should be put away in tight boxes with a little naphthaline, which can easily be evaporated off again when they are wanted for use.

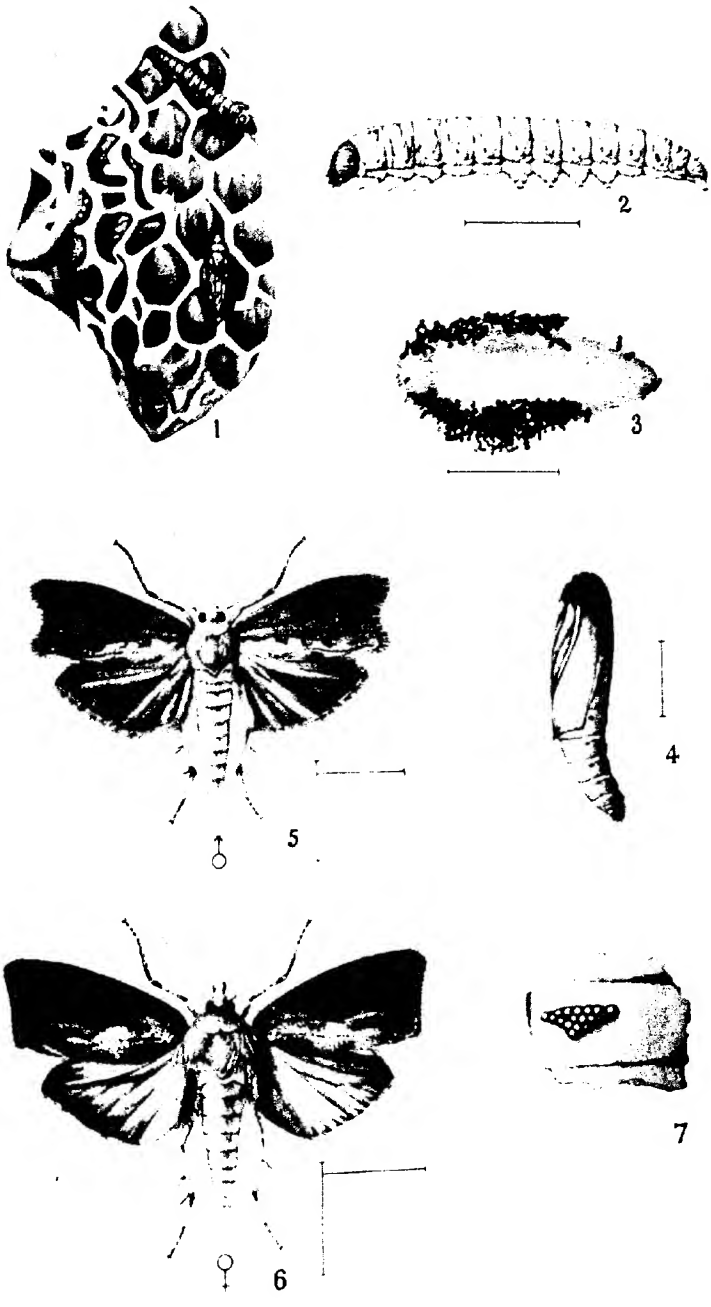
Explanation of Plate.

Wax-Moth (Galleria mellonella, Linn.)

Fig. 1. Piece of comb, showing Eggs, Caterpillar and Moth in resting position. Natural size.
,, 2. Caterpillar (full-grown).
,, 3. Cocoon.
,, 4. Pupa.
,, 5. Male moth.
,, 6. Female moth.
,, 7. Cluster of Eggs (greatly magnified).

(The natural sizes of figures 2—6 are indicated by the hair lines shown alongside each.)

ATE XLVIII.



MANGO CULTIVATION.

By D. L. NARAYAN RAO,

Proprietor, Nursery Gardens, Hyderabad (Deccan).

THE mango is pre-eminently the fruit of India and rich and poor anxiously wait for the advent of the mango season. In gardens it is given the foremost place and its absence in any garden is a matter for regret. There are no records available as to the actual area under mango cultivation in India. This is probably due to the difficulty of securing even approximately correct information regarding the innumerable varieties scattered all over the land. The total area is undoubtedly large.

The cultivation of mangoes is not equally remunerative everywhere. In Northern India where the tree is common, good mango fruit sells at 20 seers or more per rupee, and in Hyderabad good local fruit is never sold at more than 8 seers for the rupee—the average being only 4 seers. Though Hyderabad possesses extensive gardens in and around it, yet the local supply which is available in May and June is always insufficient to meet the demand. Out of season and early in season Hyderabad gets its supply of this fruit from other parts.

The consignments of mangoes from the East Coast, Poona, Bangalore, Chittoor, Salem and other places compete fairly with the local supply even after paying railway freights for long distances.

Many people in the Deccan and other places complain that mango gardens are run at a loss. Others are planting large areas with it as a safe investment in the belief that they must pay. Some of the large mango gardens were planted by rich men when the economic conditions of the country were different from

what they are now, with the special object of getting as many good varieties of fruit as possible for personal requirements, while profit was only a secondary object. Other gardens planted partly for personal needs and partly with commercial motives are only imitations of the above with regard to principles of gardening. In them very little care is taken with respect to selection either of soils or of varieties of mango.

The idea that mangoes grow equally well in shallow and in deep fertile soils is not based on a careful observation of facts. All successful mango gardens are situated in soils which have at least a depth of 5 feet with good drainage and moisture underground. Hence the fact remains that the best yielders and longest lived and healthiest trees are found in deep fertile retentive soils. In places like the districts of North Arcot, Salem, Bangalore, Bunganpally and the vicinity of Waltair, etc., where the successful cultivation of mangoes has become traditional, the garden owners possess much practical knowledge on the subject. In these districts, varieties eminently fitted for commercial purposes were selected long ago and grown extensively with the result that these districts have been able to supply mangoes every year to distant markets up to the end of August or even later. (1) Dilpasand, (2) Thoothapari, (3) Neelam, (4) Kalapahad, (5) Nawab Pasand (Roomani) at Arcot, (6) Benishan, and (7) Shakerpara at Bunganpally in the Kurnool district are the chief commercial varieties. These varieties have spread to almost all places in Southern India and the Deccan and are easily recognised by gardeners.

The illustration given under the name of Thoothapari at the end of Professor Woodrow's book "The Mango" belongs to the real Dilpasand and not to Thoothapari.

SURE-BEARING.

The mango tree, even when grown in a suitable soil and climate, is a very uncertain bearer and it is very difficult to forecast whether the crop will be good or bad. The hundreds of varieties advertised by nurserymen might be mangoes of

PLATE XLIX

"Dilpasand" Mango Tree, Six Years Old.

very good quality, but a majority of them and a very large majority of seedling mango trees in the country are very unreliable with regard to fruit-bearing. Some of them do not even blossom once in two or three years, but the commercial varieties mentioned can be relied upon to give at least partial crops every year. If half the number of existing trees were to bear fruit every year, the local markets would be glutted and people would be compelled to find new methods of exporting surplus fruit to foreign countries.

The habit of mangoes in producing fruit varies with soil and climate. The Peterpasand of Madras is the same as the Pairi of Bombay or the Goabunder of Hyderabad or the Badami of Chittoor. Being a very rapid grower, this tree is extensively cultivated in all those places and its fruit comes very early to the market, but it is a shy bearer here.

The well-known Alphonso of Bombay, known in Madras as Kaderpasand, and its type the Russapuri of Bangalore is also a very shy bearer. The famous local Mulgoba also is a very shy bearer, but it is said to bear better at Chittoor and Bangalore. The commercial varieties mentioned above, in addition to other virtues seem to bear well in poor soils also.

Some of the best keeping varieties of mango of these parts seem to have originated in Arcot and Salem districts. Some of them keep for two months after removal from the trees. The Benishan is a speciality to Bunganpally and is probably the best mango in the Deccan.

Late-Bearing.

The majority of mango trees mature their fruit in Hyderabad in May-June. Markets then get glutted and prices suddenly fall. In many places the mango season lasts less than three months. By careful attention to late-bearing and long-keeping varieties the season can be extended from three to five months as is the case in Arcot and Salem districts. The fertile tract of country near Waltair in the Vizagapatam district is rapidly becoming a large centre of mango cultivation. The garden

owners there understand their business well. Some of their select varieties are Rajmanu, Nalla Kayala Yandrus, Koram Gova, Swantam and Suverna Rekha, etc. Some of these are probably local names given to foreign plants. Similarly, by searching in other parts of India, suitable commercial varieties can be found. The time of appearance of mango blossom and fruit varies considerably in different parts of India. This has to be definitely ascertained and kept in mind by fruit growers for their own advantage. Here in Hyderabad the mango trees commence to blossom by the 15th December. The majority of trees are in full blossom by the 15th of February.

The greatest enemies to mango blossom appear to be the innumerable small insects known as Aphides which cause what is popularly known as "Mango Honey." People think that this is caused by heavy dew. These Aphides weaken the tree at the time of blossom by sucking its sap and excrete a sort of thick viscid substance which coats the flowers and other parts of the tree like varnish making not only further fertilisation impossible but scorching much of the previously fertilised fruit. A heavy rain is supposed to cleanse the trees and in the absence of it syringing with pure water or soap suds and one per cent. of kerosene oil seems to destroy them. Spraying the trees once or twice with a weak solution of Bordeaux Mixture or Iron Sulphate previous to appearance of the blossom will be found to prove a good precaution against Aphides or other pests which infest these trees.

In America, spraying has become an essential part of gardening, but here it is unknown to cultivators. Its usefulness, importance and advantages can well be illustrated in the case of the mango tree.

Climate.—People in all parts of India are more or less partial in praising the excellence of mango fruit produced in their own locality. There is some truth in the belief among some of the best connoisseurs of mangoes in Hyderabad that even select varieties of grafted mango plants imported from distant places and cultivated here produce better flavoured fruit than the original.

An examination of fruits collected and brought from different parts of India and placed side by side reveals the fact that the fruit of one place differs from that of others in colour, general appearance, smell and other qualities. It is quite possible that the dry Deccan climate with a small average rainfall, although unfavourable to great productiveness of fruit, yet cleanses it of its resinous matters and consequently improves the flavour.

Irrigation.—Much useful information might be collected on the subject of irrigating mango gardens in different soils. The fruit produced from areas which are frequently inundated for irrigation with tank or river water or which have a high underground water-level rising almost to the roots is always inferior to that produced in gardens situated on well-drained slopes and carefully irrigated. During the vigorous period of the growth of mango plants, say up to at least their eighth or tenth year, the trees should be abundantly irrigated so that they may not receive a serious check to their growth. Of course, there are exceptional soils with a high underground water-level on which mango plants do not require any irrigation after the fourth or fifth year from planting.

When fruit is our aim, particularly from well-grown trees, the whole ground under the trees should be well dug with a pick-axe and exposed in October-November after the rains are over. This operation induces the trees to blossom. The ground should remain in this state for about forty days from the time of flowering. It is very often found that if the ground under trees is copiously irrigated just when fruits are setting or when they are only about the size of marbles, the whole crop suddenly withers and drops down onaccount of the sudden rush of sap to them.

Manuring.—Manuring of mango trees with well-rotted litter in July or August once in two or three years increases the yield of fruit, but it is said that high manuring interferes to some extent with the quality. Leaf mould is always the safest manure for mango trees.

Applications of strong manures to unirrigated trees after the rains sometimes even kill them in shallow Morrum soil.

THE NARKANDA PATENT POTATO MEAL FACTORY.

By Colonel R. H. F. RENNICK.

It may interest some of the readers of the Journal to know how the "Patent Potato Meal Industry" recently (that is about two years ago) started at Narkanda in the Simla Hill District originated. About seven years ago, when Sir Edwin Collen was Military Member of Council, the question arose of providing for the British Troops for mobilisation a suitable vegetable ration which could be procured in India in time of war when communication with Europe would be interrupted. The "Mobilisation Scheme" provided the British Troops with a reserve of "Sliced desiccated potatoes" imported from England, which was turned over every two years to accustom the British soldier to its use and taste. Somehow he did not fancy them. They were hard to negotiate, much harder to digest; hours of anxious boiling and grumbling did not give him a decent meal. He loathed their issue and threw them away on service as in Tibet and elsewhere. Apart from their insipid taste, their keeping qualities were uncertain. The tins used to get mildewed and full of weevil, and large stocks had to be repeatedly condemned and replaced from England. The recalcitrant behaviour of the tuber was a source of great anxiety to Sir Edwin Collen and set him to seek a substitute which would commend itself more to the appreciative palate of the men. He then wrote and asked me, as I had already supplied several thousand pounds of apple rings for troops on service, if I could help him to solve this knotty problem. After prolonged and careful experiments with the most desirable and well-known Indian vegetables, I submitted to

him in 1905 samples which were distributed for report to the Quarter-Master-General of the Army and Principal Medical Officer of British Troops in India. The Indian vegetables were not appreciated ; but the "potato meal" was favourably reported upon and noted for further experiments. On this, in November 1906, 600lbs. of the potato meal were offered to the Quarter-Master-General free on rail at Kalka for further experimental purposes. These fresh trials being likewise satisfactory, an order for a supply of 28,000lbs. was placed with me in September 1907. On this I at once patented the meal in England and shifted my field of operations from the Kulu Valley to the Kumarsen district which is nearly the centre of the potato-growing country in the Simla Hills, the export trade of which in potatoes alone averages yearly 120,000 maunds and where are large reserves of forests with suitable trees for fuel. I acquired a suitable site about a couple of hundred yards to the north of the Narkanda bungalow, well known to visitors of Simla, installed 3 cauldrons and furnaces for boiling and drying purposes, with a hand-driven kibbling machine. The furnaces not being patented have been made at five different places in India to keep their construction secret. Each is capable of drying 800lbs. to 1,000lbs. of potatoes daily. The kibbling was done by a hand-driven machine, and the grinding by the numerous water mills around Narkanda. The tins and the cases for them were locally made but not very satisfactorily as the hill men cannot saw planks to uniform thickness. Thus, this order was met all on a venturesome speculation. When the Quarter-Master-General last year placed an order for over 106,000lbs. of meal, which means putting 5 to 6 hundred thousand pounds of potatoes through the patent process, I did not hesitate ; anxious as I was to promote the well-being of the army, I at once extended my requirements to put this order through, and to make the speculative factory a permanent one, self-supporting in every respect. I imported a 5-horse power Campbell Oil Engine to drive the new kibbling and grinding machines which are capable of turning out 80 maunds or some 6,400lbs. of meal a day. The peeling and the slicing are

entirely done by numerous hand machines. On an average 80 hands are employed daily to keep furnaces going. Ten skilled stokers, who have been properly trained to do the work, are employed, for everything depends on the successful roasting of the sliced potatoes to turn out a satisfactory meal. The tuber can only be satisfactorily mealed when it is in prime condition; no sooner does it begin to "sag" or get soft or to germinate than it is utterly useless for mealing purposes.

The chemical analysis of this meal by Messrs. Treacher & Co. of Bombay, and the Chemist of the Chamber of Commerce in Paris is as follows:—

	Per cent.
Salts	6
Fat	0·4
Carbo Hydrates	84·1
Proteids	9·5
Water:	slight moisture.

The analysis of the salts made separately shows that the meal contains $2\frac{1}{2}$ per cent. of potash salts together with traces of iron and ammonia salts which are a valuable asset in its favour as an "anti-scorbutic." This verdict or opinion of the analysts is contested by the Military Surgeons who maintain that "desiccation" destroys this property. However this may be, Mr. Calvert and his party on his mission to Tibet four years ago and Mr. David Fraser on his Central Asian journey and their followers who lived entirely on Rennick's patent potato meal, were free from scurvy. I have presented Captain Scott of the Antartic Polar Expedition with 500 free rations to be reported upon as to their anti-scorbutic properties. Unlike the prohibition in force at most factories on the Continent of Europe, in France, Germany and Hungary where it is almost impossible to obtain admission either to a flour mill or gun factory, visitors to Narkanda are welcomed by the owner of the factory who takes great pleasure in showing them over his installation. The venture promises to be a success, for the factory is installed in an "ideal locality" for the development of the industry. Numerous private orders are received

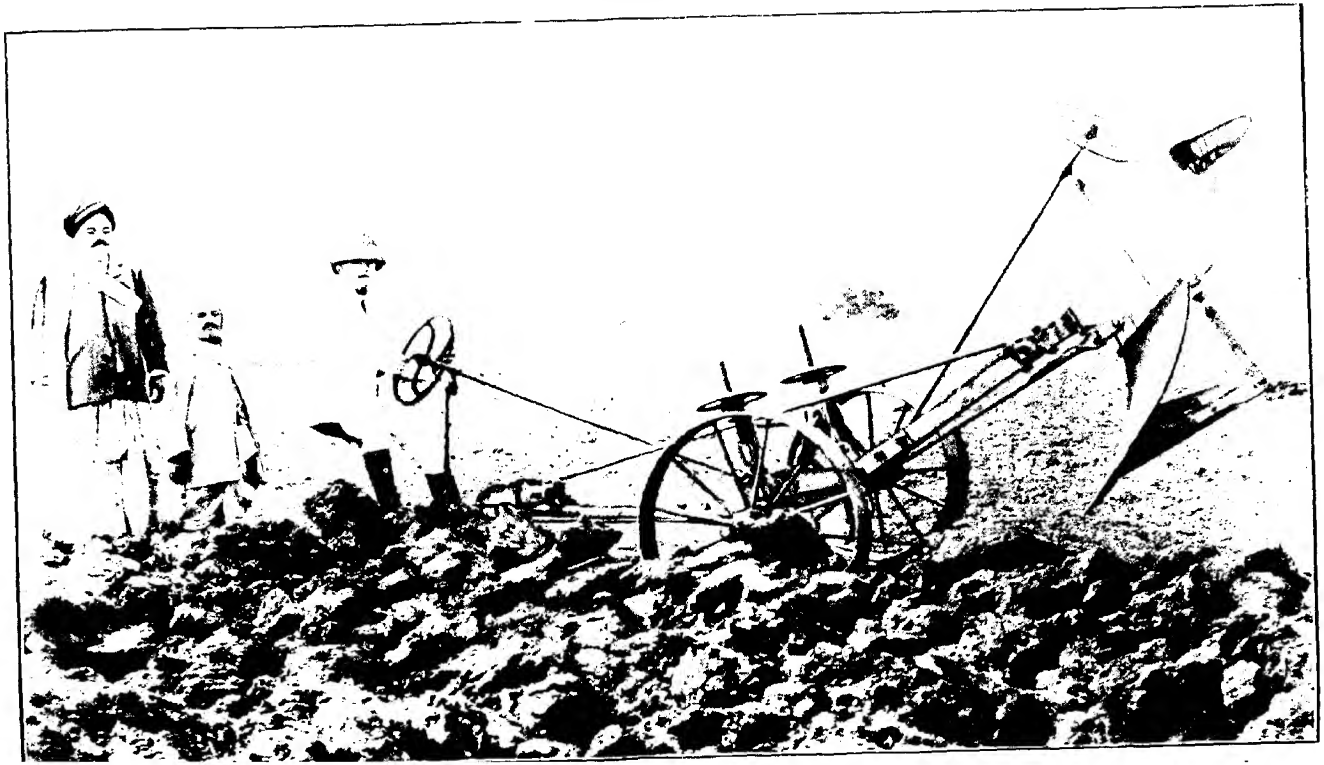
daily which are met with diffidence for fear of falling short of the quantity booked by the Quarter-Master-General.

One firm was anxious to place orders of 10 *tons at a time* which have been gratefully declined until "Tommy Atkins" has been provided for.

NOTES.

Cattle Insurance.—Cattle form a large and valuable portion of a farmer's stock-in-trade. With a view, therefore, to compensate themselves for the loss they sustain from the death of their cattle through contagious diseases, accidents and the like, farmers in many European countries have formed themselves into mutual cattle insurance societies. As the risk of mortality of cattle largely depends upon the owner himself, an organisation formed of the cattle-owners of the neighbourhood or of the same district has been found to exercise an effective control over its members as regards the manner in which the animals are kept, and at the same time to be economically administered, with the result that the premiums to be paid come to a very small sum. The one principle which has been found essential to success is that no compensation should ever be paid for animals dying from ill-treatment on the part of the owner. This makes the owner careful in tending his animals. In some societies a premium is charged on each head of cattle insured, in others it is not fixed but is the result of the apportionment among the members of the total amount of compensation to be paid by the society. But the latter method has this disadvantage that the insured does not know beforehand the cost of his insurance which may vary considerably from year to year. Full compensation is not generally paid, but only three-fourths of the value, to stimulate the diligence of the owner in the protection and good treatment of his animals. In Germany every important illness of the insured animal must be reported to the insurer who in some cases provides gratuitous veterinary assistance. Societies have found it more convenient to insure groups of animals, as individualisation for payment of compensation is difficult and

PLATE L



easily admits of fraud. The compensation is usually equal to the mean value of the animals.

In India owing to the increasing prices of draught and milch cattle, the want of a means of insuring the farmers against the losses of their cattle is becoming every day more apparent. The Village Co-operative Credit Societies which are being rapidly multiplied, and are bringing home to cultivators the manifold advantages of co-operation, are very like the small mutual insurance societies obtaining in Europe. They could add very much to their usefulness if they took up this important line of work. (EDITOR.)

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DEEP-PLOUGHING. The difficulty of ploughing deep by means of direct traction is well known. It has been estimated that in some soils in Europe it requires 14 horses to plough 1 ft. 7 in. deep with direct traction, and that beyond this number of horses practically no advantage can be gained by adding further horses to the team, on account of the loss of power which must of necessity result when the team is increased. This difficulty is severely felt in some tracts of the Bombay Presidency where the cultivators habitually plough about 10 inches deep with the heavy wooden plough, and use up to 5 and 6 pair of oxen to do so. The same difficulty is found in many places by sugar-cane cultivators who wish to plough 1 ft. deep. The introduction of various patterns of turn-wrest plough has done much to solve the difficulty: but it has been found that there are some stiff black soils which are very difficult to plough in the hot weather, and that for eradicating *hariali* grass (*cynodon dactylon*) from deep black soils it is necessary to go deeper than a foot. The difficulty is greatly increased by the size of the clods of earth which are turned up by the plough: and which are so large and stiff that it is almost impossible for the cattle to walk over them. In order to tackle this problem the question of steam ploughing had been considered, but the difficulty of finding the funds (Rs. 40,000) for the trial was too great. It was, therefore, decided to try a large balance plough with two gearings, and the plough

and gearings, as shown in the pictures, were ordered from A. Bajac, Liancourt (Oise), France. The cost was as follows :-

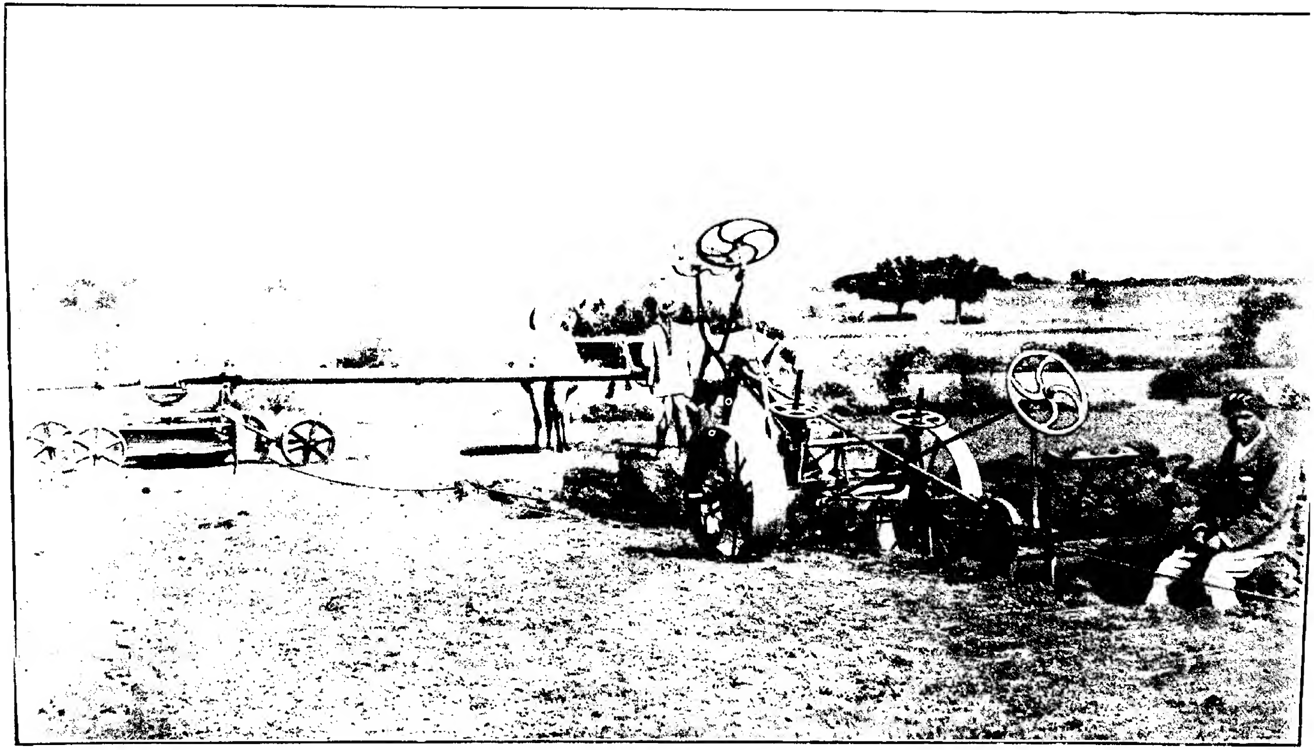
	Rs.
Two gearings with all accessories	1,875
Two small jack screws	62
One (breaking up) balance plough (weight 636 kilos) ...	596
Painting, packing, etc	238
Freight to Bombay	329
TOTAL Rs. ...	3,100

The plough has been in use for two months in the black soil area in the south of the Bombay Presidency. It has two cables, each 230 yds. in length joining it to the gearings; so the gearings can be fixed up about 220 yds. apart, and the plough works slowly from one to the other opening a furrow 16 in. deep and 16 in. broad. It does very good work, and affords an excellent means of dealing with black soil infested with deep-rooted grasses. It offers an easy load with one pair of good bullocks on each gearing. The only thing against it is that it works very slowly. It ploughs 11 gunthas in 9 hours. This, of course, means a short day for the cattle since each pair will only be working for $4\frac{1}{2}$ hours: and the working day might easily be extended so that one-third of an acre could be ploughed in the day. The possibility of working a two gang plough in this way will also be considered. Meantime the plough has met with the warm approval of large cultivators in the Dharwar District, and many are desirous to hire the tackle at the rate of Rs. 3 a day and to work it with their own cattle and labourers. It is at present being hired out at Rs. 100 a month with a man to look after it.

Taking these rates, and the 9-hour day as a working basis, the net advantage to be gained by using this plough works out as follows. It will plough 11 acres in 40 days.

Hire of plough for 40 days at Rs 3 a day	Rs. 120
Wages of one man and two boys for 40 days at Re 1 a day ..	40
Hire of 4 bullocks for 40 days at Rs. 2 a day	„ 80
TOTAL ...	Rs. 240
Cost per acre ...	Rs. 22 (about)

PLATE LI.



Showing Balance Plough and Gearing with Bullocks attached.

The rates given above have purposely been pitched high, and the figure per acre is an outside one. If the plough is worked for six months in the year and Rs. 3 a day charged, it will bring in Rs. 540 a year, or about 17½ per cent. on outlay, which will allow amply for interest, depreciation and repairs.

As against Rs. 22 per acre for cleaning land by the plough the cost for hand digging is Rs. 40 per acre; and hand digging does not go so deep as the plough.—(G. F. KEATINGE.)

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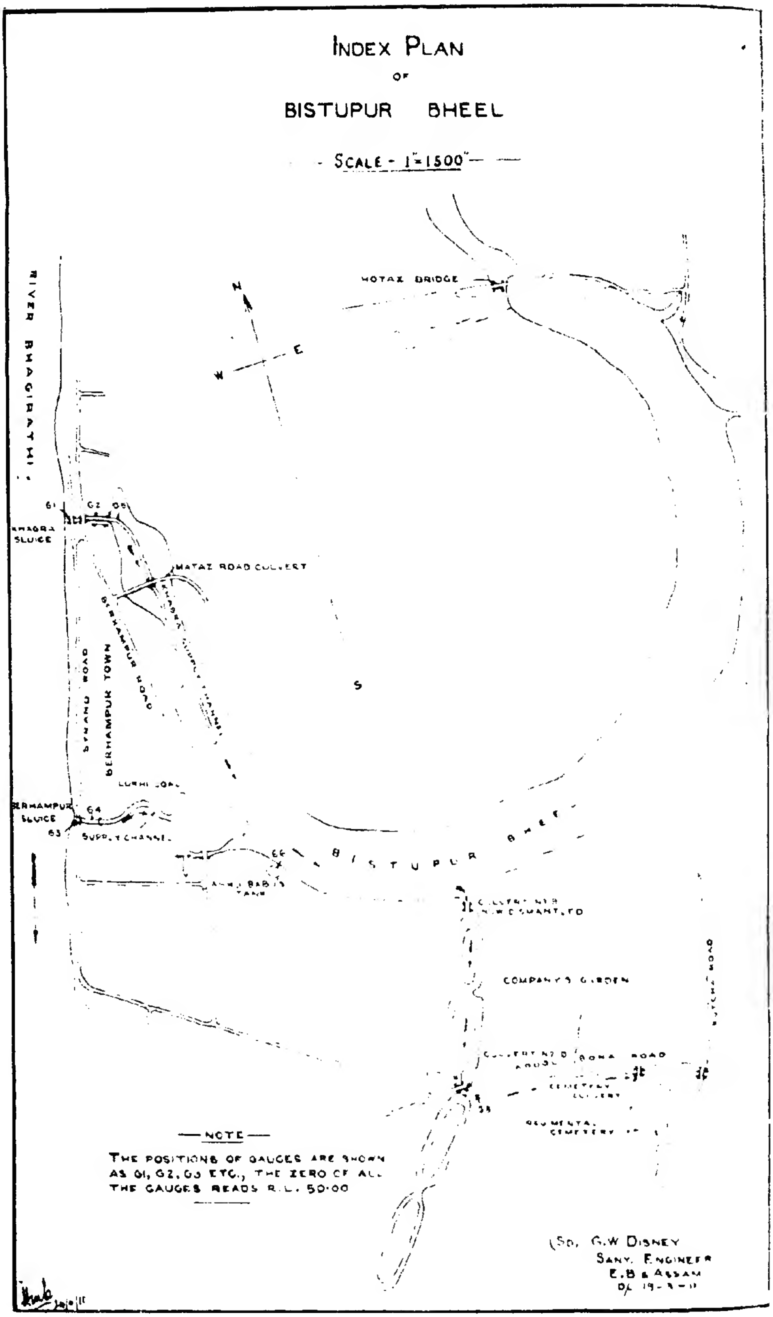
RECLAMATION OF LAND BY DEPOSITION OF SILT.—We have been favoured with a copy of a recent inspection note by Mr. G. W. Disney, Sanitary Engineer to the Government of Eastern Bengal and Assam, on silting work at Berhampur (Bengal) and Multrapur (Maldah District) which, in view of the importance of the subject, we reproduce *in toto*.

"I inspected the silting operations at the Bistupur Bhil close to Berhampore on the 9th March accompanied by Mr. C. W. Sibold, Executive Engineer, Nadia Rivers Division, who is in immediate charge of the work, and those in the Multrapur Estate carried out by Mr. G. Hennessy, on the 11th both of whom were good enough to give me all available assistance and information.

"2. The Bistupur Bhil is of horse-shoe shape (see plan attached), lying to the North East of the station of Berhampur. The inception of the scheme was due to a recommendation of the Bengal Drainage Committee that this bhil, to which is assigned an area of two square miles, should be drained. On surveys being made the estimated cost worked out to a prohibitive amount. Attention was then directed to natural accretion by silt deposit, and local conditions in the shape of existing sluices and escapes being available, merely requiring adaptation and remodelling, the necessary expenditure was comparatively small (some Rs. 12,000), and was sanctioned.

"3. The system adopted is that of the current flowing in one direction, the deposition of silt being due to the diminution of the velocity of the current as the water spreads out in the



INDEX PLAN
OF
BISTUPUR BHEEL
SCALE - 1"=1500"
RIVER BHAGIRATHI
N
E
W
S
KHAGRA SLUICE
BERHAMPUR TOWN
BERHAMPUR ROAD
BERHAMPUR SLUICE
SUPPLY CHANNEL
B I S T U P U R B H E E L
COMPANY'S GARDEN
NOTE
THE POSITIONS OF GAUGES ARE SHOWN AS G1, G2, G3 ETC., THE ZERO OF ALL THE GAUGES READS R.L. 50·00
(SD.) G.W. DISNEY
SANY. ENGINEER
E.B. & ASSAM

bhil. This effect is aided by the growth of aquatic plants—which further assist in checking the velocity. The mean velocity in the Bhagirathi river, as given by Mr. Buckley, is 2·8 feet per second, and the quantity of dry silt by weight in the water at this velocity as $\frac{1}{1,200}$ (damp silt contains 57 per cent. of dry silt and 43 per cent. of water and 1 cubic foot of dry silt weighs 78 lbs.). As a volume of only some 200 cubic feet per second is admitted by the sluices, there has not to be much spread out in area to reduce the velocity to a silt-depositing one. The flood period has been approximately noted at 90 days during which time silting action will go on. The bhil is fed through two sluices, the Khagra, or upper one, with its floor at a low level, and the Berhampore one at a higher level. This enables the flood water to be admitted when the afflux at the Khagra sluice would render it dangerous to keep the shutters open. The discharge culvert at the southern outlet is capable of discharging 200 cubic feet per second. In July 1910, the maximum quantity of water entering the bhil with both sluices open was 241·25 cusecs, and the discharge 137·69 cusecs. The quantity of silt it is calculated will be required to fill up the bhil is 125 lakhs, and the rate of deposit 8 lakhs per year. The time this will take is therefore 16 years. In 1909 the silt deposit as calculated from cross sections of the bhil was 3, and in 1910, 8 lakhs; in the former season the works were not fully completed. The silting up has therefore cost on the capital expenditure, omitting maintenance charges which so far have been small, at the rate of Rs. 10·9, say Rs. 11, per thousand cubic feet, and for the required amount of 125 lakhs on the same calculation the cost will be about Re. 1 per thousand cubic feet. Even if this figure be trebled, the result would be good.

"4. Mr. Hennessy's work at Multrapur has been based on the flood and ebb system, as compared with that of 'the straight flow through' one adopted at Berhampore. This may be called the open, mouth system. He informs me he has been working this for the last 15 years, and has reclaimed many hundred bighas of bhil land which formerly was valueless, but now

commands a high rental. The class of land he showed me and the crops growing on it could not be surpassed. His system merely consists of an open channel leading to the Ganges from an enclosed bhil. As the flood rises, the silt-laden water flows in and comes to rest when the silt is deposited, and as the water level falls, the decanted water drains off, the ebb and flow are as a rule sufficient to keep this channel open, and the fall in the Ganges is not so rapid as to cause disturbance to the newly deposited silt. This is the system in use on the brickfields on the banks of the Hooghly River, where the pits from which earth has been excavated are annually made good with river silt and nothing more simple and effective can be imagined. Some years ago I designed a decanting sluice so as to prevent the tidal fall disturbing the silt-settling action, but in the Ganges the fluctuations of level are so gradual that this is not necessary, and all that is required is that a still back water be formed.

"5. My personal experience of the open mouth silt-catching pit is worth recording. Some years ago, I had an abutment of a long iron viaduct outflanked on the down stream side, and commenced enclosing this within a ring bund working in segments. The first year the silt had accumulated to low flood level; the open mouth was then reduced year by year until average ground level was attained, when it was closed, and the embankment made secure. On the other hand, in a somewhat similar case, through not grasping the local conditions, I failed signally in my attempts, but fortunately with no bad results. This is merely recounted to show that each river has its own special character, and that its moods must be studied before anything approaching satisfactory results by utilising it can be expected. It is with the object of gaining preliminary information that it was urged in my note of the 1st October 1910 that silt observations be extensively made; as the proportion of silt in the water varies from $\frac{1}{218}$ in the Megna, $\frac{1}{300}$ in the Sone, $\frac{1}{1100}$ in the Bhagirathi, to $\frac{1}{2,917}$ in the Kusiara Rivers. Bonificazone, or the improvement of land by drainage and silt deposit, is a subject which has come to stay in India. In Italy 'it is considered a

grave error not to profit by fertile silt whenever it is available,' and it is inconceivable that this view will not in time be generally held in this country also."

* *

Fish Culture as a means of controlling Malaria in Rice Fields. (Bekämpfung der Malaria durch Karpfen). *Oesterreichische Fischerei-Zeitung*, S. 86, Wien, März 1, 1911.

There are about 200,000 hectares of rice fields in the valley of the Po, which are covered in summer with water to a depth of from 20 to 30 cm. The rice zone is very frequently infested with malaria.

The breeding of carp has been tried in the rice fields, and for some years past excellent results have been obtained. The young fish, barely 10 mm. in length, are put into the fields from the end of June. By the month of September, they are already large, and are found in sufficient quantity to yield a quintal of fish per hectare.*

Four or five francs will buy enough fry to stock a hectare, and there is no further expenditure. Rice-field carps are well nourished and have a fine flavour. The rice also seems to derive benefit from the presence of the carp, for the fields where these fish are raised have given an additional 5 to 6 quintals of rice per hectare.

The fish clear the plants of vegetable and animal enemies and devour the larvae of the Anopheles thus contributing to render the malarial zone healthy. (*Bulletin No. 3, March* 1911, *of the Bureau of Agricultural Intelligence and of Plant Diseases, International Institute of Agriculture, Rome.*)

From another abstract in the same Bulletin, it appears that the excellent results probably referred to, were obtained under the direction of the Hydrobiological Station of the Municipality of Milan, where no doubt adequate expert supervision was available. Elsewhere the practice was tried and abandoned. The

* Quintal per hectare = [illegible] seers per acre.

fate of this new industry will be watched with interest in India.

GRAFTING MANGOES.—The following suggestions for experiments in the grafting of mangoes are taken from a lecture read by W. Burns, B.Sc., Economic Botanist, Bombay, to the members of the Deccan Agricultural Association.

"The usual method practised in the Deccan is to put seeds of any kind of mango into small pots. These seeds develop into seedlings, and, when two or three years old, are taken out beside large trees of good quality and have scions from these trees grafted on them by the tongue-graft by approach method, or by simple enarching. In the latter form two cut surfaces are placed together. In the former a tongue is cut in both stock and scion and the union is more secure. I have not seen any other method of grafting practised by ordinary growers. In the Bassein and Ganeshkhind Botanical Gardens we occasionally cut off a branch from a tree of good variety and graft it in the nursery on the seedling by means of the whip graft. Both these methods have one serious disadvantage. The seedling as it develops finds no room for its roots in the small pot, and its growth of stem is likewise stunted. Now it is impossible to graft satisfactorily on a thin stock, and moreover, when a root system that has been cramped in a pot is placed in the field, it is difficult for these stunted and tangled roots to take a grip of their new situation and the whole plant may languish. The obvious remedy for this is to plant the mango stones for stocks right into the pits, and graft on the seedlings from them, in the field, by means of the whip graft. By planting the seeds at once in the pits, we get a strong healthy root system in a natural relation with its surroundings, and a correspondingly strong and healthy stem on which we can easily graft. There are, however, certain objections which may be raised against this method: (1) that on the whole the whip graft is not so successful as the approach method; (2) that the graft is exposed to sun, wind and animals and is thus not likely to take. Are these objections valid?

The whip graft is, I believe, in the hands of an expert, as satisfactory as the tongue-graft by approach. The exposure of the grafted plant can be avoided by properly constructed shades and shelters. I recommend, for experiment, the planting of mango stones in the field where the plantation is finally to be, and the grafting on the seedling stocks there raised, of good scions, by means of the whip graft. The whip graft is made by a long slanting cut, in scion and stock, of equal thickness: and the putting of these together, as a lash is tied to a whip handle. A modification of this method, which may be also tried experimentally, is to make the tongue-graft by approach in the usual way, and then take the grafted plant to the field and use its branches as scions, to graft by tongue, by approach, on the mango stocks there raised. Both the methods I have just described are, I think, well worthy of a trial, and have the great advantage of giving a vigorous and natural root system to the plant. Dr. Mann, again, tells me that a similar point in tea culture has been decided in favour of the nursery raising of seedlings.

* * * * * *

One cannot leave the subject of grafting without some reference to the systems of crown and side grafting. If the top of a tree, or of a thick branch, has become useless, either through attacks of "Bandgul," insects or any other cause, there is still no necessity to lose the tree or the branch. Cut off the diseased top of the tree, and, between the bark and the wood, insert one or more scions, of good variety, and carefully tie and cover. Where these crown grafts take, their growth is astonishing. They are supplied by an enormous root system and, consequently, go on making one growth continuously after another, so that, in a very short time, the amputated top is replaced. Side grafting is a similar method applied to the side of a tree. A method of grafting termed *strap grafting*, recently described in an Australian journal, is one which I have not tried. Budding the mango has been recommended in various journals from time to time. Experiments with budding in Ganeshkhind and Bassein gardens

have, however, proved unsuccessful: and I see no reason for abandoning the easy and well-tried methods of grafting for the difficult and doubtful process of budding."

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A NOTE ON THE USES OF CLEISTANTHUS COLLINUS IN THE NAGPUR DIVISION OF THE CENTRAL PROVINCES: Cleistanthus collinus Benth. Syn. *Lebidieropsis orbicularis*, Vern. *Garari* is a small deciduous tree most commonly growing as coppice. The information mentioned by Dr. Watt in the Dictionary of Economic Products is the statement made by Roxburgh that the bark or outer crust of the capsule is reported to be exceedingly poisonous, and it is stated by the Rev. Dr. Campbell that the fruit and bark are employed in Chota Nagpur to poison fish. The following additional notes on the poisonous properties of the tree are of interest. An enquiry arose out of the fact that a few leaves with some bark from the root of a tree were sent in for identification: the only information supplied was that they were taken from a tree very common in Chanda which was noted for its hard wood. The reason for the enquiry was that a woman had confessed to killing her husband by giving him a decoction of the bark of the root. The specimen was identified as *Cleistanthus collinus* and the following additional information came to light in the enquiry. A party of Gonds from Balaghat district who had come to the bazar were shown the specimen and recognising it said that the leaves were poisonous and the root much more so. They used the leaves for poisoning fish in streams. The stream was dammed up and a number of basketfuls of leaves were thrown on the water. After two or three days when the leaves had rotted the fish were killed. Mr. Low, Director of Agriculture, was able to supplement this information. In Balaghat district there was a case of poisoning in which a woman was accused of killing her husband by giving him a decoction of the root. The case could not be proved as no poison could be isolated. The evidence, however, clearly pointed to the cause of death being the bark or root of the *Garari*. Another interesting use is made of this

plant in the same district. When the rice crop is attacked by stem borer, it is the custom to throw the leaves on to the water in the rice land in order to prevent the spread of the insect.

With regard to the chemical nature of the poison Greshoff mentions that there is Hydrocyanic acid present (*Kew Bulletin*, 1910, 10, 403), while Dekker has separated from the bark tannin, saponin and a crystalline phytosterin (Pharm. Weekblad, 46, 16, 20).—(R. J. D. GRAHAM.)

REVIEWS.

RAMIE (RHEA), CHINA GRASS. THE NEW TEXTILE FIBRE BY H. A. CARTER.

THE volume before us, composed of sixteen chapters and covering 140 pages, contains a great deal of information regarding rhea, ramie or China grass, which cannot fail to be of use to anyone desiring, in a compact form, a fairly comprehensive survey of the whole subject.

The early part of the work deals with the botanical and agricultural sides of the question, following which the technical problems involved in the processes of decorticating, degumming, spinning and weaving receive attention. The last seven chapters include :—

(*a*) Statistical and general commercial information regarding the progress of the rhea manufacturing industry in Great Britain, the continent of Europe, America, South Africa and China.

(*b*) A specially interesting account of the numerous uses to which ramie is capable of being put.

The order Urticaceæ, the nettle family, to which the genus Boehmeria (containing rhea) belongs, includes many valuable fibre-producing plants. Owing, however, to the difficulties attending their cultivation and extraction, none of them, excepting ramie, is being commercially exploited. There are two species of true rhea, *viz.* :

(A) *Boehmeria tenacissima.*

(B) „ *nivea.*

The former is a truly tropical plant, while the latter, which is distinguished by the white undersurface of its leaves, is capable of cultivation in semi-tropical, and even in temperate,

climates. *Boehmeria nivea* is the source of the rhea fibre produced in China and known as "China Grass."

It is also the plant with which the numerous attempts to introduce rhea cultivation, on a large scale, into India have been made. Both the varieties of *Boehmeria* are botanically distinct from the "Ban" or wild rhea, which is *Villebrunea integrifolia*, and which is found in the jungles of Assam, the Terai and in similar tracts in other parts of India. All three plants share the property of containing excellent fibre.

The fibre of rhea, like those of jute (*Corchorus capsularis*) San Hemp (*Crotalaria juncea*), *mestapat* or Bimlipatam jute (*Hibiscus cannabinus*), is found in the bark of the plant. Of the latter commonly occurring fibres, San Hemp is the only one which approaches rhea in regard to quality: its cellulose content, which indicates durability, being approximately the same as that of rhea fibre. In all other respects rhea is incontestably superior. Its ultimate filaments are probably four times as long as those of any other fibre. Its strength is three times that of hemp, four times that of flax and eight times that of cotton. Nevertheless, its fibre can be separated to such a degree as to enable it to be spun and woven into materials almost as fine as those made from silk. It is less flexible than cotton; but this apparent defect might, quite possibly, be removed by a modification of the treatment the fibre undergoes in the course of preparation. It is as white as bleached cotton and its lustre is superior to that of fine linen.

With all these superlative qualities, rhea may well be called the king of vegetable fibres, and it is little wonder that persistent efforts have been, and are still being, made, both by agriculturists and by manufacturers, to overcome the difficulties which stand in the way of its being used on as cale more commensurate with its value than is the case at present. These difficulties are more than ordinarily complex. The plant is far more sensitive than those at present commonly grown for fibre. It demands the richest lands, with copious manure, and while it requires a heavy and evenly distributed rainfall, it is killed at once by

anything approaching water-logging of the soil. Further, the crop occupies the land for several years, during which no other crop can be produced and, as rhea takes two years, after planting, to mature, the land is virtually unproductive during this period.

When the crop has been produced, it is found that the fibre cannot be extracted by the comparatively cheap method of retting, such as is employed in the case of jute and other similar fibres. It is necessary, therefore, for this purpose, to resort, either to extremely tedious manual methods, or, to expensive machinery. The manual methods are so slow as to be impossible of application, excepting when the cultivation is on a very small scale, unless efficient labour is plentiful and extremely cheap. On the other hand, the decorticating machines at present on the market, though expensive, are by no means perfect, as they tend to break up, and therefore to lose, a considerable proportion of the fibre during the extraction process. They are particularly wasteful with short stems which, in some cases, cannot be cleaned at all. Under such conditions, it is obviously only the long stems which can be counted on as fibre producers and the difficulty of the agricultural problem is therefore intensified. In 1869 and again in 1877, the Government of India offered prizes of £5,000 (Rs. 75,000) and £2,000 (Rs. 30,000) respectively for machines or processes by means of which rhea could be economically and efficiently extracted; but the prizes were, in view of the absence of competitors of sufficient merit, ultimately withdrawn.

Even after its extraction, a subsequent chemical treatment of the fibre, called degumming, is necessary before it can be prepared for spinning.

It is obvious therefore that the expenses of the production and extraction of rhea are very great; but if these were compensated by a correspondingly high price for the prepared fibre, there would still be a prospect of a profit to the cultivator. Unfortunately, it can hardly be doubted, that the price of rhea is not commensurate with its real value, as compared with other

fibres; the result being that the amount of rhea produced is very small indeed. Even including China the total area under rhea must be far less than 100,000 acres, *i.e.*, less than one-thirtieth of the area devoted to jute in Bengal.

The rhea fibre produced in China is entirely the result of a cottage industry. It is really only partially cleaned, being, more or less, in the form of ribbons, which retain the original form of the bark. The method of extraction of "China Grass," though tedious, is simple and is entirely a manual process. The price of "China Grass" in China is said to be about £24 per ton or about Rs. 13 per maund.

The cultivation and extraction of rhea in Northern Bengal and in parts of Assam is probably carried out under conditions rather similar to those obtaining in China. In Northern Bengal the individual areas are very small indeed, varying usually from a patch containing a few roots, to about $\frac{1}{10}$ acre, the average probably being nearer $\frac{1}{40}$ acre. The cultivation of rhea is, of course, by no means universal amongst the raiyats and the produce is entirely consumed in the local markets where its price is said to vary from Rs. 2 to Rs. 6 per seer, *i.e.*, at the rate of about £150 per ton. The method of extraction is described as extremely tedious and the cultivation is expensive on account of the large amount of manure required. With their jute cultivation, far easier, cheaper and very profitable, even at much lower prices than Rs. 10 per maund,* it is unlikely that the raiyats of Bengal would take up the cultivation of rhea for Rs. 13 per maund.

Even the machine-cleaned rhea, produced five years ago by the Bengal rhea syndicate (since liquidated), was only worth from £28 to £36 per ton landed in London. The manufacturers, by whom, of course, these prices are fixed, contend that they cannot afford to pay more for the raw material: because the position of rhea fabrics in the world's markets is not sufficiently secure, to enable them to raise the price of the finished product without automatically diminishing the consumption. For the

* Jute has reached this value twice in the last five years.

present, therefore, it is probable that China will continue to supply the world's demand for rhea.

The foregoing remarks are suggested by a perusal of Mr Carter's book. The chapters on the agricultural side of the question are, in our opinion, too optimistic. We do not, for instance, find ourselves in whole-hearted agreement with statements like the following :—"and experts are agreed that, if the authorities will foster and protect the cultivation, India will become one of the most important rhea-producing countries in the world." Even if there were large areas of land in India, naturally suited for the cultivation of rhea, it must not be forgotten that such lands are also capable of producing heavy yields of crops which might, apart from the less trouble involved in their cultivation, pay better than rhea could hope to do, at present prices. Tobacco and jute may be quoted as possible instances of such crops in Northern Bengal. As a source of accurate first-hand information on the agricultural aspect of the rhea problem, we would prefer to recommend to intending cultivators of rhea the article "Rhea Experiments" contributed by Mr. B. Coventry, Officiating Inspector-General of Agriculture, to the *Agricultural Journal of India* (Vol. II, Part I, January 1907).

The chapter on decorticators contains descriptions with illustrations of the Lehmann, Faure and Schlichten machines. Of these, one or other of the forms of the Faure machine would, at present, appear to be the most satisfactory because, being at least as efficient as other machines on the market, units of the small type might be worked on a comparatively small area. On the other hand, a number of such machines can be economically linked on a larger area ; or, one of a larger type could be substituted. The Faure machine can only be relied on to produce $2\frac{1}{2}$ per cent. of good fibre out of a possible 5 per cent., the remainder being broken or cut away in the process of decortication. Such fibre as is cleaned is, however, of good quality : the parallelism of the fibres in the ribbons is not seriously disturbed and the fibre obtained from them is equal to that extracted, in a similar

manner, from China Grass. A disadvantage of this machine which is probably equally characteristic of other decorticators is its inability to deal satisfactorily with short stems. This being so, it is obviously only the longer stems—say, those over 3 ft. long—which can be taken into account in estimating the possible yield of fibre per acre. In some cases the proportion of short stems may be so large as to cause, by their inclusion or rejection as fibre yielders, the difference between success and failure. It is just possible for instance that if, in the recent expensive experiments in Behar, all the stems, long and short, could have been economically dealt with, the results might have justified a continuance of the cultivation. The matter is thus obviously a serious one, well worthy of the attention of engineers. It is only due to the Faure machine to say that, in the trials in India, it never had the best crops to work on and that, in a district better suited to the growth of rhea than Behar, it might yield quite sufficiently satisfactory results.

A new ramie decorticator has recently been reported from America, *viz.*, the "Schlichten" machine, which has been favourably reported on by the American Government Botanist. The tests were, however, performed with dry retted hemp, and not with ramie, so that the recommendation would appear to be of doubtful value. The machine is a large one, weighing 3 tons and requiring 7 h.-p. to work it. It could therefore only be used on a large plantation.

In the chapter dealing with the history (subsequent to the year 1853) of the ramie trade in Great Britain, the author shows that it is by no means a uniform record of success. There are, however, at the present time several mills in England which are profitable enterprises. "Sail-cloths and large quantities of incandescent gas mantles are manufactured at these premises and the enterprises have been at work successfully for some years." We learn with interest that the sails of the yacht "Shamrock I," in the races for the America cup, were made of ramie instead of flax. Being the strongest of all fibres and, at the same time, lighter than flax, it is obvious that "vessels can

carry a greater expanse of ramie sail-cloth than if their canvas were made of flax."

In this connection the author asks why British-grown ramie cannot wholly replace the foreign-grown flax for which Great Britain pays some millions sterling annually. "Degummed in a satisfactory manner, and rightly combed afterwards, ramie is quite equal to these" (the finest grades of foreign flax) "in regard to fineness, strength, elasticity, ductility and all those good qualities which go to make a textile fibre—identical in appearance to flax, while considerably cheaper." This is all perfectly true: but if such a desirable consummation is to take place, the price of rhea must rise before its cultivation in India would be worth while. The present position is only to be explained by supposing (*a*) that the manufacturers at present in the trade, content with a handsome profit on their working, are not anxious to see a great extension of the trade and a consequent increase of competition, which is not likely to benefit them. In this connection it may be remarked that the average annual dividend of the Erste Deutsche Ramie Gesellschaft of Emmendingen, for the last twelve years, has been nearly 9 per cent., but during the last five years it has averaged 12 per cent. and in 1907 and in 1908 it was 15 per cent. The only other possible explanation of the anomalous position of rhea in the world's markets is, (*b*) that the present demand for rhea fabrics is not sufficient to outstrip the production of "China Grass." In this case it is not to the interest of the Indian planter, or cultivator, to compete with China in order to lower the price of the raw material to benefit the European manufacturer; but it might, on the other hand, be possible for profitable rhea-manufacturing concerns to be taken up in India, somewhat in the manner suggested on p. 85 of the book under review. A rhea manufactory in India should have the same chance of success as the similar enterprises in Europe, which are, as we have seen, making handsome profits. In the event of a rise in the price of raw material, Indian concerns would still be in as favourable a position as before; especially if it became worth the while of the Indian cultivator to produce

rhea on a large scale. Such a scheme as this would appear to be the only way, at present, of developing a rhea industry in India. Preliminary efforts, it may be said, are already being made in this direction.

A few words regarding the manifold uses to which rhea can be put may be interesting. "As the strongest of all fibres and by reason of its non-liability to rot when immersed in water, it is especially suited for the manufacture of sail-cloth, tent canvas, ropes, cords, fishing lines and nets. For these purposes it is unquestionably superior to all other textiles in regard to its lasting property. Woven into tent canvas for military purposes, tents made from the fibre can be transported in less wagon space during warfare, a matter of the first moment. Fire engine hose...belting and...towellings, etc., etc." It is more serviceable than cotton in the manufacture of water-proof goods, and everyone knows now that rhea makes the best framework for incandescent gas mantles. "The best quality of fibre is spun into yarns used in the manufacture of brocades, damasks, fine tapestries...plushes, velvets, lace goods ..and goods which can supersede some of the finest qualities of linen." Most people know that rhea materials for underclothing and summer suits can now be obtained: but few have tried them. It is well worth their while to do so.

The following quotations from Mr. Coventry's article (*loc. cit.*), form an admirable summary of the position of rhea, with which we are in entire agreement. They are well worth reproducing here:—"The price of rhea is regulated by the supply from China, which is the over-production of an indigenous industry: the demand is from a small handful of European spinners who appear entirely to control the trade."......"The prices which spinners are now offering for the raw product are quite out of proportion to its intrinsic merits, and the consequence is that there is no inducement for cultivators to extend their operations. The quality of the land and the high class of agriculture required for the growth of rhea call for a greater value for the raw product...... there are other crops that pay better than rhea. If spinners are

truly desirous of developing this important crop, they must...... offer prices more commensurate with the intrinsic value of the product."......When we consider that rhea is "both a textile and a cordage fibre," the lowness of its price "is a matter for some astonishment." Manilla Hemp and Agave are worth from £20 to £80 per ton; flax from £30 to £150 per ton and the price of jute, a fibre of an entirely lower class, has twice, in the last five years, exceeded £25 per ton. In view of these figures Mr. Coventry may well ask:—"How is it that the finest fibre in the world can, with difficulty, realise £26 to £38 per ton?"

The sense of these remarks is pertinent to this review; because our perusal of Mr. Carter's book seems to indicate that he holds rather the view of the European manufacturer than that of the producer, in regard to the price of raw rhea. We believe it probable that, if the price of the fibre were to rise to £40 per ton (Rs. 22 per maund), serious attempts might be made in India to extend its cultivation, with a view to export; but until some such substantial inducement is made, it is not likely that the Indian planter or cultivator will respond in any degree.

In conclusion, we wish to say that, although we do not agree with all Mr. Carter's views in regard to the agricultural side of the rhea question, we have, nevertheless, read his book with interest. The chapters dealing with the manufacture of rhea fabrics and also his review of the prospects of rhea in different parts of the world are full of information. The numerous illustrations are very well done and there is a fair index.

The book is published by the Technical Publishing Co., Ltd., 55 & 56, Chancery Lane, London, E.C.—(R. S. Finlow.)

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REPORT OF THE INDIGO RESEARCH STATION, SIRSIAH, FOR THE YEAR 1910-1911. BY CYRIL BERGTHEIL, SCIENTIFIC OFFICER, BEHAR INDIGO PLANTERS' ASSOCIATION, MUZAFFARPUR.

THE report is very disappointing owing to the fact that the biological work of the past two years was destroyed by the disastrous flood of last August. This is the more to be regretted

because of the certain indications which exist that there is a wide scope for the improvement of the Indigo-producing power of the plant. To quote Mr. Bergtheil's own words: "Out of 100 plants, all under uniform conditions and apparently at the same stage of growth, analysed within a fortnight in one field, the highest was found to be capable of yielding ·79 per cent. of indigotin from the leaf and the lowest ·34 per cent., the average yielding power of the whole lot being ·52 per cent. This indicates very much wider variation than the results previously recorded from smaller numbers of analyses have done, and means that the possibilities of improvement by selection are, correspondingly, even greater than had formerly been supposed .. ..we can, I think, now state with assurance that the Java plant, as it now stands, can be improved in its potential indigo-yielding power by an amount of the order of 50 per cent. at least."

This is an important statement and let us hope that if not all, at any rate a large proportion of this increase may eventually be obtainable on a commercial scale, for it would go a long way in establishing natural indigo on a secure basis.—(EDITOR.)

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DISEASES OF THE ARECA PALM I. KOLEROGA. BY LESLIE C. COLEMAN, M.A., PH.D., MYCOLOGIST AND ENTOMOLOGIST TO THE GOVERNMENT OF MYSORE. Department of Agriculture, Mysore State, Mycological Series, Bulletin No. 2, 1910.

THIS is a very full account of the disease of Areca palms in South India, first described under the local name of *Koleroga* in the *Agricultural Journal of India*, Vol. I, 1906, p. 399. Dr. Coleman considers it to be one of the worst fungus diseases to be found in India. The area affected consists of one large continuous tract in the western portion of Mysore extending over the ghats into Canara, and a second smaller one in South Malabar and the adjacent portion of Cochin State. This is all a region of high rainfall, reaching about 300 inches in the ghats themselves. Within this area the Areca nut is one of the most

valuable crops grown, the returns from a successful garden being very high. In the western part of Mysore the total value of the crop exceeds 40 lakhs of rupees and the revenue yielded by it to Government is about two lakhs yearly.

The disease attacks chiefly the nuts, which are rotted and fall off. Occasionally the top of the tree is also infected, the bud being destroyed and the palm killed. In badly affected gardens the loss may amount to 75 per cent. or even practically the whole crop. Dr. Coleman estimates the annual loss to be at least 3 to 4 lakhs of rupees. The first appearance is usually soon after the monsoon breaks in July, and the nuts continue to fall for some months. Fallen nuts in the early stage of the disease are found to have lost their clear green colour and usually the surface is partially covered with a soft whitish growth. This growth consists of the mycelium of the fungus *Phytophthora omnivora* var. *Arecæ*, which causes the disease. In moist weather this fungus gives rise to numerous small swimming spores, which are set free into the films of water covering the bunches or are carried in rain drops from nut to nut. After a short period of motion the spores come to rest and germinate by a little thread-like filament which is capable of entering into the tissues of the nut and also of other parts of the crown of the palm. Here it grows and extends throughout the living cells, killing them and rotting the tissues. Ultimately groups of filaments burst out on to the surface where they form a new crop of spores. In addition to this evanescent type of spore a durable form is produced sexually which is probably capable of preserving its vitality for considerable periods. This has not so far been found naturally on the Areca palm itself, but has developed in Dr. Coleman's cultures and also on other plants inoculated with the *Areca phytophthora*. Since the disease remains over from year to year in the gardens, it is not unlikely that further search will result in finding the resting spores on the palm itself. Besides the Areca palm, Dr. Coleman succeeded in inoculating a number of other plants. In Europe and elsewhere the same fungus is known to attack many different species, some of economic

importance. The same is quite likely to be the case in India. In one instance, however, that of the fruit rot of Cacao so destructive in Ceylon and indeed wherever Cacao is grown, another *Phytophthora* was found, which Dr. Coleman showed was not identical with the Areca parasite.

One of the most interesting sections of the paper is that in which the experiments in the treatment of the disease are described. The Areca growers have themselves devised a method which, though troublesome and imperfect, is still of interest as being one of the few cases of intelligent attempt made to check plant diseases in India. It consists of binding covers made of the basal sheaths of the Areca palm leaves over the bunches, to keep the rain off them. Since water on the nuts is necessary for the spread of the disease by spores, anything which tends to keep them dry will naturally diminish the spread. But these covers are not universally used, are easily dislodged by the wind or rotted by the rain and the method is not very successful. Hence Dr. Coleman carried out an extensive series of spraying experiments, with more promising results. The mixture used was that known as Bordeaux mixture, made of 5 lbs. copper sulphate, 5 lbs. quick-lime and 25 gallons water. To this was added resin and washing soda to increase its adhesive properties. Sufficient to spray one acre costs Rs. 3 to Rs. 4, but it is hoped to reduce this. The mixture was applied by means of a small sprayer, worked by compressed air and capable of being slung on the back of a palm climber. The climbers are very expert in ascending the palms and even habitually swing themselves from tree to tree without the labour of descending and remounting. This enables them to spray a large number of trees in a day, about three times as many as could be provided with bunch covers under the old system.

The results obtained in the first year's experiments show that a single application made early in June just before the monsoon, was more effective in checking the disease than using covers. Thus in one garden the percentage of loss of nuts when sprayed was between 6 and 7, according to the date of the

spraying, when tied with covers 10, and when untreated 40. These experiments are being continued, and show considerable promise of success.

The bulletin is copiously illustrated and an abstract of the scientific work done in connection with the disease has been published in the Annales Mycologici for December 1910. (E. J. BUTLER.)

BULLETIN OF THE BUREAU OF AGRICULTURAL INTELLIGENCE AND OF PLANT DISEASES—ISSUED BY THE INTERNATIONAL INSTITUTE OF AGRICULTURE.

THIS Bulletin is issued monthly, and promises to be an exceedingly useful publication. It consists of abstracts taken exclusively from books, periodicals, bulletins and other publications received in the Library of the Institute in Rome, where they are dealt with by a staff of abstractors.

The abstracts are less numerous than those given in the Experiment Station Record of the United States Department of Agriculture but fuller, and contain, in many cases, sufficiently detailed information to be of value without reference to the original publications. Provided that all publications of importance are received by the Institute and that the abstracting is done with scientific discrimination, both these differences are in favour of the new publication, particularly from the point of view of the agriculturist who has not access to a large library.

At present the abstracts are merely grouped under cognate heads, but arrangements will no doubt be made for indexing as the numbers accumulate.

It is to be hoped that the Institute will receive such support from the agricultural public, as well as from official and scientific bodies, as will ensure, both that all important publications of agricultural interest reach the Library in Rome and that an efficient staff of abstractors and translators be maintained. (A. C. DOBBS.)

BULLETIN NO. 200 OF THE UNIVERSITY OF WISCONSIN EXPERIMENTAL STATION, WISCONSIN, U. S. A.

THIS Bulletin should be read by all interested in the economical production of milk. It shews that in the North-West of the United States, rations of a very wide albuminoid ratio are successfully fed to heavy milking cows. The bulletin is based on the results of trials extending over 9 years, with a herd of cows of extraordinary productive capacity, which for 6 out of the 9 years gave an average of over 7,600 pounds a year per cow of milk containing about 4·2 per cent. of butter fat. As a result of these trials the albuminoid ratio recommended for the ration of large cows producing not more than 1lb. of butter fat daily, is wider than 1 to 8; while a ratio narrower than 1 to 7 is recommended only for the feed of small cows producing over 1½lbs. of butter fat daily.

These recommendations are contrary to the teachings of European Agricultural Scientists who have recommended the feeding of at least 50 per cent. more protein under similar circumstances. The American figures seem to be more in accordance with practical experience, and, as their adoption would effect a saving of probably half the expenditure that would be incurred, for purchased foods, by the adoption of the standards generally recommended in England and other European countries, owners of dairy herds who are guided by scientific principles in feeding their cattle would do well to give the recommendations contained in this bulletin a trial. (A. C. DOBBS.)

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BOLLETTINO DEL LABORATORIO DI ZOOLOGIA GENERALE E AGRARIA DELLA R. SCUOLA SUPERIORE D'AGRICOLTURA IN PORTICI. Volume IV. Portici: 1910. (Pp. 354, text-fig. 145. Price 20 Lire)

THIS, the latest part of a series which commenced in 1907 and which promises to give us an annual volume, forms a worthy companion to its three predecessors. Although nominally devoted to general and agricultural zoology, all four volumes are

almost entirely occupied with papers on Economic Entomology, the leading feature being the careful working out of the life-histories and bionomics of some of the insect-pests most seriously prejudicial to agriculture in Italy. It need scarcely be stated here that an important point, to which attention must be directed in working out the life-history of an insect-pest with a view to reducing its numbers, is the consideration of the enemies which normally prey on it and keep it within bounds. This fact receives especial prominence in the publication under review. We are all familiar with the old rhyme which asserts that

> "Big fleas have little fleas
>   Upon their backs to bite 'em,
> And little fleas have lesser fleas
>   And so *ad infinitum*."

but it is as a rule only the professed Entomologist who realises the immense complexity of the subject of parasitism. A destructive insect, such as a Caterpillar, may, for example, be parasitised by a second insect which lays its eggs in, and whose larvæ live on the tissues of the first: this second insect is beneficial as it destroys the first, but may itself be parasitised by a third insect, which we must look on as injurious because it destroys the beneficial parasite: and this third insect may be parasitised in its turn by yet a fourth, which lives at its expense; and so on. It is therefore not every parasitic insect which is beneficial, a fact which is often not realised or forgotten. Sometimes, indeed, a parasite may fill a double rôle, as is the case of a small Chalcid mentioned in the present volume, which is beneficial when it attacks the caterpillars of *Sitotroga cerealella* (the destructive Angoumois Grain Moth), but injurious when it is a hyperparasite on *Apanteles glomeratus* which is itself a parasite of the Cabbage Butterfly (*Pieris brassicæ*).

Many of the species dealt with in these volumes are not as yet known from India: but many of the genera are identical and the observations on habits, damage done, and means of prevention, cannot fail to interest the Entomological worker in

India. The text-figures are excellent and the text itself written in a style combining lucidity with scientific exactitude. We congratulate the Portici School of Agriculture on the production of an extremely interesting and useful series of papers.—(T. BAINBRIGGE FLETCHER.)

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HANDBOOK OF THE DESTRUCTIVE INSECTS OF VICTORIA. PART V. BY C. FRENCH, GOVERNMENT ENTOMOLOGIST.

THIS is the fifth part of an eminently useful series of small Handbooks initiated by Mr. French twenty years ago and intended to be completed by a sixth part, now in course of preparation. All the insects dealt with are well figured in colour, and a short account is given of their life-history and means of control.

As in the preceding volumes, of which the fourth was reviewed in this Journal (Vol. V, pages 182-183), many of the insects dealt with are exclusively Australian, but several of these have representative species in India, very similar in their relationships, habits, damage and means of control. Such are the "Butterfly of the Orange" of which we have two common and destructive species belonging to the same group: "the Dark-striped Tiger Moth" (*Diacrisia canescens*), represented in India by the Behar Hairy Caterpillar (*D. obliqua*): and "Boisduval's Fig-tree Borer" (*Batocera boisduvali*), paralleled by our common Mango Borer (*B. rubus*).

A few of the insects dealt with, chiefly cosmopolitan or widely-distributed and well-known species, are identical with ours: such are the Sweet Potato Weevil (*Cylas formicarius*), the Rice Weevil (*Calandra oryzæ*) and the Grain Weevil (*C. granaria*).

Besides destructive insects, the volume under review contains coloured figures and descriptions of twelve Australian birds which are useful to the agriculturist as devourers of noxious insects. Following Jerdon's account, the Spine-tailed Swift (*Chaetura caudacuta*, Latham) is stated to breed in the Himalayas, but this is not an Indian bird: our white-necked Spine-tail (*Ch. nudipes*, Hodg.), which was erroneously identified by Jerdon

as the Australian species, being confined to Northern India. The subject of insectivorous birds is one which has lately received a certain amount of attention in India, and a Memoir of this Department, on the actual food of Indian birds, has lately been published.

The subject of the importation of insect and fungal pests is one which is receiving due attention in Victoria and an interesting report by the Senior Inspector of Fruit Exports and Imports embodies the regulations now in operation. Not only Nursery Stock, but bananas, *Citrus* fruits, potatoes and tomatoes are only allowed to be imported under a system of rigid inspection. It is interesting to note also that the local transfer of potatoes is under strict supervision: unfortunately, such measures of internal control seem impracticable in India, where the Potato Moth (a lately introduced pest) is steadily spreading from one district to another. As Mr. French remarks (p. 82), we cannot be too careful in regard to shipments, as, once the pests are introduced, they usually come to stay." (T. BAINBRIGGE FLETCHER.)

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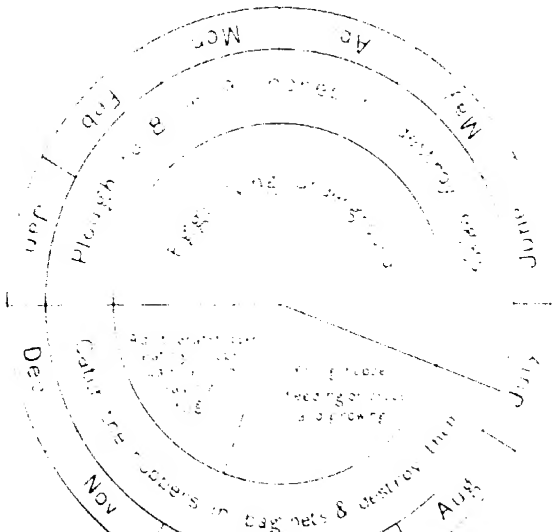
"THE JOLA OR DECCAN GRASSHOPPER (COLEMANIA SPHENARIOIDES)." DR. L. C. COLEMAN. Mysore State Department of Agriculture, Entomological Bulletin, No. 2. Bangalore Government Press, 1911. Price Re. 1.

THIS Bulletin, comprising 43 pages and 10 plates (of which two are coloured) and 8 figures in the text, deals with a wingless grasshopper, native to the South of India, and which has quite recently manifested a liking for crops. It is particularly to be noticed that this grasshopper is not an introduced species but an indigenous form which has apparently, until within the last few years, led a comparatively harmless existence in the Deccan as a grass-feeder: owing to the extension of cultivation or other causes it has however exhibited a preference for cultivated cereals, and the more abundant nutriment thereby afforded has enabled it to increase its numbers until it has become a very serious pest.

In the case of cereals, indeed, "not only are the leaves eaten but also the grains in the heads, the result being that in a severely attacked field practically nothing is left but the stalks or stems of the plants and the empty ears;" in the case of pulses, however, the grasshopper contents itself with eating the leaves and flowers, leaving the pods and seeds untouched. Although the adult grasshopper is incapable of flight, it appears to be spreading rapidly in cultivated tracts, being largely assisted in its distribution by the transport of individuals in carts, etc., across natural obstacles such as streams.

The life-history is very similar to that of the Cane and Rice Grasshopper, the eggs hatching after the early monsoon rains have fallen in July, the young hoppers feeding from August to October, the adults damaging the crops in November-December, then pairing and dying off, leaving their eggs hidden in the soil. The diagram shows the annual life-cycle in graphic



form, and the remedial measures to be adopted at different times of the year. These latter are the same as in the case of the

Cane and Rice Grasshopper and consist in (*i*) giving a deep ploughing whilst the egg-masses are still in the soil to bury them to a depth from which the young hoppers cannot emerge or destroy them by exposure on the surface; (*ii*) catching the hoppers (especially, of course, when they are young and before they have done much damage) by means of large bag-nets dragged through the young crops. As the author remarks, however, "the work of bagging should be looked upon in the same light as weeding, something which should be repeated at regular intervals." If hoppers do not come in from surrounding unbagged land, three or four baggings should be sufficient. In a case cited, where a cultivator owning eight acres in the middle of a badly infested area deep-ploughed his land and bagged enthusiastically in 1910, the crop harvested was worth Rs. 240; the deep-ploughing had reduced weeding-expenses by Rs. 10, whilst the owner estimated the expenses attached to bagging the whole area at only Rs. 6-9 including cost of bag. In 1909, when no remedial measures were adopted, the total outturn from these eight acres was only valued at Rs. 10 and hardly repaid the work done on the land These figures speak for themselves.

The list of natural enemies of this grasshopper is very meagre, comprising only a few birds, a lizard, a predaceous fly, and a Blister Beetle whose larva feeds on the egg-masses; probably further research will be repaid by the discovery of endophagous parasites which may be utilised in fighting this pest.

We notice one slight *lapsus calami*; the predaceous fly figured on Plate VII, fig. 8, being described on page 12 as a *Syrphus*; on page 26 it is correctly referred to the *Asilidæ*.—(T. BAINBRIGGE FLETCHER.)

EXPLANATION OF PLATE OF DECCAN GRASSHOPPER.

(*Colemania sphenarioides, Bol.*)

Fig. 1. Shows a *bajra* plant attacked by the grasshoppers. The leaves have been gnawed and nearly all the grains eaten.

Fig. 2. Shows two adult hoppers on the ground; the individual on the left hand has thrust its abdomen into the soil and is laying eggs.

PLATE LII.

The Year Book of the United States Department of Agriculture for 1910 appears again in the form with which all students of State-aided agriculture are now familiar. The report of the Secretary unfolds the usual marvellous tale of American agricultural prosperity, and the fact that the annual value of agricultural products in the States is estimated to have nearly doubled in the last 12 years justifies, at all events from the producers' point of view, the optimism that is the keynote of these reports.

Of individual crops cotton now comes second in total value, being exceeded only by maize. Interesting information is given concerning these two crops. Of cotton it is said that it "yields a marketable product with less water than any other crop now grown in the South West," and it is implied that the production of cotton in America can still, in spite of the boll weevil, be enormously increased.

A statement that carefully bred varieties of cotton have been found to be abnormally variable when introduced to a new locality, and that re-selection for some years is necessary before the normal yield is obtained, throws a suggestive light on the failure of many of the attempts that have been made to introduce exotic varieties into India. A type of Egyptian cotton has been bred and successfully grown on a field scale in South California and Arizona, and varieties of the well-known Mit-Afifi have been acclimatised by selection.

One of the most effective means of improving the cultivation of maize has been the formation of "Corn-Clubs," to which over 46,000 boys in the States now belong. These clubs give prizes for the growth of large yields of maize; and boys, after studying the improved methods advocated, have succeeded in growing up to 200 bushels per acre, on their fathers' farms, at a low cost. It is found that these methods are very rapidly adopted as a result of this system of demonstration.

While these typically American crops are thus continually being developed at one end of the scale, the maintenance and enhancement of the vigour of imported staples is being systematically

ensured at the other. With characteristic enterprise and remarkable insight the Americans have gone to the scenes of the beginnings of man's dominion over nature for this purpose. The explorers of the office of Plant Introduction have found wheat growing wild on the slopes of Mount Hermon; apricots, cherries, olives, alfalfa and another species of Medicago, in Turkestan; grapes, peaches, crab apples and a strawberry in the Caucasus; all possessing either in their produce or in their capacity to resist drought and cold, qualities which it is hoped to utilise by grafting or crossing with American staple varieties.

The Department's activities cover a wide field; the importance of controlling rats by making the permanent conditions unsuitable for their increase is mentioned in another section of the report, in which it is also stated that the California ground squirrel has become infected with plague. When the number of small rodents in America and their wide distribution is considered, it can only be hoped that the prairie dogs of the middle West are not destined to play the same part in harbouring plague in America as the marmots, from Manchuria to the Caucasus, are now supposed to play in Asia.

It is impossible adequately to review these reports in a limited space. Incidentally they give the impression, to one who has not been in America, that agriculture there is still in its infancy, but the truth probably is that, in the development of farming on extensive lines, the old knowledge fell largely into disuse in the necessity for, and advantages of, development in a totally different direction. The Yearbook, naturally enough, does not concern itself much about points in which the American practical farmer already excels. It is remarkable that out of 476 pages—excluding the appendix—the space devoted to the horse and the pig consists of two short paragraphs, on army horses, and on swine fever, which together would occupy exactly one page. A reference to the statistics in the appendix, however, shews that there are 21 million horses and 47 million pigs in the States—over four times as many horses and five times as many pigs per head of the population as in the United Kingdom.

The horse is the backbone of American agriculture, and the pig must play much the same part in the economy of the disposal of crops under the American extensive system, that the horse does in their production. Meanwhile the possibilities of the development of intensive cultivation have, over a large part of the country, apparently been lost sight of and remain to be exploited. How the United States Department of Agriculture is taking advantage of this fact, while keeping well to the fore in original investigations, this and previous Yearbooks show.

From this point of view and owing to the valuable statistics it contains, the Yearbook will always be of interest to students of agriculture and economics outside America; but the agriculturist in older countries must not expect to find in it the information which would be of most value to him—the details of the methods, of the intelligent use of livestock, by which the American farmer who has not got any great stock of capital, can pay an average wage of nearly a dollar a day and yet make farming pay. (A. C. Dobbs.)

"Notes on classification and examination of the canes at present indigenous to Bengal." By C. S. Taylor, B.A., Departmental Records, Department of Agriculture, Bengal. Twenty-five varieties of sugar-cane, all indigenous to Bengal, have been grown at Sabour and examined at intervals, during the ripening period. Data regarding proportions of juice expressed, the estimated amount of sugar left in the bagass and the composition of the juice are given.—(J. W. Leather.)

"The Revenue Administration of the United Provinces."—By W. H. Moreland, C.I.E., I.C.S., published by the *Pioneer Press*. We are glad to see this the latest volume from the pen of Mr. Moreland. Starting with a brief resume of the earliest revenue system, dating as far back as 1300, the author conducts the reader by easy stages through the period of Mahomedan rule to the revenue settlements of the past century and the present

time. The term "landholder" is explained in Chapter VII. In the following chapter the amount of revenue and its relation to the total produce are made clear. Following this are details of tenancy legislation in the two Provinces. Thirteen chapters are then devoted to an explanation of the Land Record System, rent litigation and collection of revenue. Chapter XXVI is devoted to an explanation of the Principles of Famine Relief. The remaining seven chapters are devoted to agricultural deterioration and improvement and to Co-operative Credit. In his Introduction the author explains that the volume has been written principally for the advantage of the young members of the Indian Civil Service when first becoming acquainted with district revenue work. Mr. Moreland's efforts will no doubt meet with ample success in this respect: indeed, we may go further and express the belief that the book will be found of considerable interest to members of other Indian Services who come into contact with the people. The volume is written in Mr. Moreland's lucid style and sets out graphically the difficulties which frequently beset the revenue officer. A quotation from Chapter XXIII on "Partitions" will illustrate this:—"probably the division of the site (abadi) causes more friction than matters of much greater pecuniary importance; questions of the right to a yard on which the houses of several claimants open, look petty in court, but their importance can be realised when the court is held, for the time being, in the yard in dispute, and the proceedings can include the interjections of the ladies of the families affected: and it is probably the experience of a good many officers that a large site cannot be partitioned satisfactorily except on the spot."—(J. W. LEATHER.)

LIST OF AGRICULTURAL PUBLICATIONS IN INDIA FROM THE 1st FEBRUARY TO THE 31st JULY 1911.

No.	Title.	Author.	Where published.
	General Agriculture.		
1	The *Agricultural Journal of India*, Vol. VI, Parts II and III. Price per part, Rs. 2. Annual subscription Rs. 6.	Agricultural Research Institute and College, Pusa, Bengal.	Messrs. Thacker, Spink & Co., Calcutta.
2	Report on the Flax Experiments conducted at Dooriah during the year 1910-11. Bulletin No. 25 of the Agricultural Research Institute, Pusa. Price 6 annas or 7 pence.	E. M. Vandekerkhove, Flax Expert to the Behar Planters' Association.	Government Printing, India, Calcutta.
3	Note on the Present Position of Cotton Investigation in India. Bulletin No. 26 of the Agricultural Research Institute, Pusa. Price 2 annas or 3 pence.	Bernard Coventry, Offg. Inspector-General of Agriculture in India.	Ditto.
4	Annual Report of the Board of Scientific Advice for the year 1909-10. Price Re. 1.	Board of Scientific Advice for India.	Ditto.
5	Area and Yield of certain Principal Crops in India for periods from 1896-97 to 1910-11. Price 4 annas or 6 pence.	Commercial Intelligence Department, India.	Ditto.
6	Notes on Sugar in India. Price Re. 1-12.	F. Noel Paton, Director-General of Commercial Intelligence, India.	Ditto.
7	Report of Flax Work at Dooriah Factory for the year 1909-10.	E. M. Vandekerkhove, Flax Expert to the Behar Planters' Association.	Ross & Co.'s Press, Muzafferpore.
8	The Cultivation of Guavas near Poona, Dharwar and Limbgaon. Bulletin No. 40 of 1911. Price 12 annas or 1 shilling 2 pence.	L. B. Kulkarni, L. Ag., Probationer under the Economic Botanist, Bombay.	Government Central Press, Bombay.
9	Groundnuts in the Bombay Deccan. Bulletin No. 41 of 1911. Price 4 annas or 5 pence.	G. K. Kelkar, Asst. Prof., Agricultural College, Poona.	Ditto.
10	Note on Long-stapled Cotton in Sind. Bulletin No. 42 of 1911. Price 3 annas or 3 pence.	G. S. Henderson, N.D.A., N.D.D., Deputy Director of Agriculture, Sind.	Ditto.
11	An Examination of the Seed Supply of the Broach District. Bulletin No. 43 of 1911. Price 5 annas or 6 pence.	G. D. Mehta, L. Ag., B.A., N.D.A., N.D.D., Probationer in charge Seed Testing Operations.	Ditto.
12	Cultivation of Broach Cotton in Dharwar. Translation in Canarese of Bulletin No. 33. Price 4 annas.	M. L. Kulkarni, Divisional Inspector, S. D., Bombay Presidency.	Ditto.
13	The Mandalay Experimental Station. Cultivator's Leaflet No. 26.	Department of Agriculture, Burma.	Government Press, Burma, Rangoon.

LIST OF AGRICULTURAL PUBLICATIONS—*contd.*

No.	Title.	Author.	Where published.
	General Agriculture—contd.		
14	Notes on Tree Cotton Cultivation in Burma. Cultivator's Bulletin No. 5.	E. Thompstone, B.Sc., Deputy Director of Agriculture, Burma.	Government Press, Burma, Rangoon.
15	Season and Crop Report of Burma for the year ending 30th June 1911. Price 6 annas or 6 pence.	Department of Agriculture, Burma.	Ditto.
16	Scientific Report of Agricultural Station, Samalkota, for 1910-1911.	G. R. Hilson, B.Sc., Deputy Director of Agriculture, Northern Divn., Madras.	Government Press, Madras.
17	Scientific Report of Agricultural Station, Hagari, for 1910-11.	Ditto.	Ditto.
18	Ditto, Bellary, for 1910-11.	Ditto.	Ditto.
19	Scientific Report of Agricultural Station, Nandyal, for 1910-1911.	Ditto.	Ditto.
20	Scientific Report of Agricultural Station, Central Farm, Coimbatore, for 1910-11.	R. Cecil Wood, B.A., Principal, Agricultural College, Coimbatore.	Ditto.
21	Scientific Report of Agricultural Station, Palur, for 1910-11.	H. C. Sampson, B.Sc., Deputy Director of Agriculture, Southern Division, Trichinopoly, Madras.	Ditto.
22	Scientific Report of Agricultural Station, Koilpatti, for 1910-1911.	Ditto.	Ditto.
23	Scientific Report of Agricultural Station, Taliparamba, for 1910-11.	Ditto.	Ditto.
24	The Home Farm, Sivagiri Estate, Tinnevelly District, Madras, Bulletin No. 62, Vol. III. Price 6 annas or 6 pence.	J. M. Lonsdale, N.D.A., N.D.D., Agricultural Expert, Court of Wards, Madras, assisted by A. Rama Rao Avargal.	Ditto.
25	Note on Sugarcane Cultivation on the Western Coast. Leaflet No. 2 in Malayalum.	Umikrishna Menon.	Government Press, Madras
26	A Dialogue on Single Planting of Paddy. Leaflet No. 3, in Tamil.	Kolandamlu Udayar.	Ditto
27	A Note on Wild Indigo. Leaflet No. 4, in Tamil and Telugu.	A. Rama Rao, Home Farm Superintendent, Sivagiri.	Ditto.
28	Improvements in Ryats' Lands. Leaflet No. 6, in Telugu and Uriya.	G. R. Hilson, B.Sc., Deputy Director of Agriculture, Northern Division, Madras.	Ditto.
29	Advantages of using Iron Ploughs in Black Cotton Soils. Leaflet No. 7, in Telugu.	Ditto.	Ditto.
30	Manuring in the Kistna. Leaflet No. 9, in Telugu	Ditto.	Ditto.
31	Dhaincha—*Sesbania Aculeata*—New Green Manure Crops Leaflet No. 10, in English, Tamil and Telugu.	H. C. Sampson, B.Sc., Deputy Director of Agriculture, Southern Circle, Madras.	Ditto.
32	Cambodia Cotton. Leaflet No 11, in Canarese.	G. R. Hilson, B.Sc., Deputy Director of Agriculture, Northern Division, Madras.	Ditto.
33	Reprint of Single Planting of Paddy and Green Manuring, in Tamil.	H. C. Sampson, B.Sc., and C. Narayan Iyer.	Ditto.
34	Lists (5) of Seeds available for Sale in Northern Division, in Telugu.	G. R. Hilson, B.Sc.	Ditto.

LIST OF AGRICULTURAL PUBLICATIONS—*contd.*

No.	Title.	Author.	Where published.
	General Agriculture—contd.		
35	Note on Sugarcane Cultivation Leaflet No. 13, in English.	M. Govinda Kidaore.	Government Press, Madras.
36	Hints to Owners of Ginning Factories. Leaflet No 16, in English.	M. E. Couchman, I.C.S., Director of Agriculture, Madras.	Ditto.
37	Some Hints for Agricultural Associations, Bulletin No. 9.	Central Agricultural Committee, Madras.	Ditto.
38	Some Insect Pests of India. Bulletin No. 10.	Ditto.	Ditto.
39	Recommendations for the Work of the Department in assisting the Agricultural Shows of Bengal Departmental Record No. 2 of 1910 (not for sale).	E. J. Woodhouse, B.A., Economic Botanist, Bengal.	Bengal Secretariat Press, Calcutta.
40	Agricultural Statistics of Bengal for 1909-10. Price Re. 1-4.	Department of Agriculture, Bengal.	Ditto.
41	Season and Crop Report of Bengal for 1910-11. Price 6 annas.	Ditto.	Ditto.
42	*Quarterly Journal of the Department of Agriculture, Bengal*, Vol IV, Nos. 3 & 4 (January and April 1911). Price 6 annas per part.	Ditto	Ditto.
43	Annual Report of the Agricultural Stations in Eastern Bengal and Assam, for the year 1909-10. Price annas 12.	Department of Agriculture, E. B. and Assam.	Government Secretariat Press, Shillong.
44	A Circular Letter to Cultivators in the Khasi Hills (Khasi and English).	Ditto.	Government Press, Shillong.
45	Yearbook of the Agricultural Department of Eastern Bengal and Assam, 1318 B. S. Price 2 annas.	Ditto	Ditto.
46	Rules for Supply of Seeds, Manures and Implements at Reduced Rates, to Honorary Correspondents and Associates of the Department of Agriculture, Eastern Bengal and Assam.	Ditto.	Ditto.
47	*Krishi Samachar* of the Agricultural Department of E. B. and Assam, 1318 B. S. (in Bengali). Price 2 annas.	Ditto.	Ditto.
48	Note on Cattle Survey in Central Provinces. (Price not fixed).	Department of Agriculture, C. P.	Central Provinces Secretariat Press, Nagpur.
49	*Agricultural Gazette*. A monthly publication, February 1911 to July 1911. Price 2 annas per copy.	Ditto.	Department of Agriculture, Central Provinces, Nagpur
50	Notes on the Cultivation of Lucerne Bulletin No. 6 (revised).	Department of Agriculture, United Provinces.	Government Press, United Provinces, Allahabad
51	Note on the Foot and Mouth Disease of Cattle in the United Provinces. Bulletin No. 24.	E. W. Oliver, M.R.C.V.S., F.Z.S., Superintendent, Civil Veterinary Department, United Provinces.	Ditto.
52	Proceedings of the Agricultural Conference held at the United Provinces Exhibition, Allahabad, in January 1911.	Department of Agriculture, United Provinces.	Ditto.
53	Pamphlet on Ensilage in Urdu and Hindi.	Dr. A. E. Parr, Ph. D., B. Sc., M. A. & M.S. in Agriculture, Deputy Director of Agriculture, United Provinces	Newal Kishore Press, Lucknow.

LIST OF AGRICULTURAL PUBLICATIONS—*contd.*

No.	Title.	Author.	Where published.
	General Agriculture—contd.		
54	Cattle and Dairying in the Punjab.	Department of Agriculture, Punjab.	*Civil and Military Gazette* Press, Lahore.
55	Annual Report of the Department of Agriculture, Baroda State. Price annas 4.	Department of Agriculture, Baroda	Baroda Printing Works.
56	Report on the Work done on the Rangpoor Farm. Price 2 annas.		R. P. W. Co., 154, Upper Chitpur Road, Calcutta.
	Agricultural Chemistry.		
57	The Indian Saltpetre Industry, Bulletin No. 24 of the Agricultural Research Institute, Pusa. Price 8 annas or 9 pence.	J. W. Leather, Ph. D., F.I.C., F.C.S., Imperial Agricultural Chemist, and Jatindra Nath Mukherji, B.A., B.Sc., Second Assistant to the Imperial Agricultural Chemist.	Government Printing, India, Calcutta.
58	Water Requirements of Crops in India II. Memoirs of the Imperial Department of Agriculture, Chemical Series, Vol I, No. 10. Price Rs. 2-8-0.	J. W. Leather, Ph. D., F.I.C., F.C.S.	Messrs. Thacker, Spink & Co., Calcutta.
59	The Composition of the Milk of some breeds of Indian Cows and Buffaloes and its variations, Part I. Memoirs of the Imperial Department of Agriculture, Chemical Series, Vol. II, No. 1. Price Re. 1-8-0.	A. A. Meggitt, B.Sc., Agricultural Chemist to the Government of Eastern Bengal and Assam, and H. H. Mann, D.Sc., Agricultural Chemist to the Government of Bombay.	Ditto.
60	The Preservation of Farm Yard Manure. Leaflet No. XIV, in English, Tamil and Telugu.	W. H. Harrison, M.Sc., Agricultural Chemist to the Government of Madras.	Government Press, Madras.
61	Notes on classification and examination of the Canes at present indigenous to Bengal. Departmental Record No. 3 of 1910.	C. S. Taylor, B.A., Agricultural Chemist to the Government of Bengal.	Bengal Secretariat Press, Calcutta.
	Mycology.		
62	Instructions for sending plants attacked with parasitic Fungi. Leaflet No. 1 in English.	W. McRae, M.A., B.Sc., Mycologist to the Government of Madras.	Government Press, Madras.
63	Note on Potato Crop. Leaflet No. 12 in English.	W. McRae, M.A., B.Sc., and G. R. Hilson, B.Sc.	Ditto.
64	Bud-rot in Godaveri and Kistna Districts. Leaflet No. 15 in Telugu.	W. McRae, M.A., B.Sc.	Ditto.
	Economic Botany.		
65	The Milling and Baking Qualities of Indian Wheats No. 3. Bulletin No. 22 of the Agricultural Research Institute, Pusa. Price 7 annas or 8 pence.	A. Howard, M.A., A.R.C.S., F.L.S., Imperial Economic Botanist, and Gabrielle L. C. Howard, M.A., Personal Assistant to the Imperial Economic Botanist, Associate and Late Fellow of Newnham College, Cambridge.	Government Printing, India, Calcutta.
66	A preliminary Note on the Classification of Paddies grown in Upper Burma. Occasional Papers, No. 1.	Department of Agriculture, Burma.	Government Printing, Burma, Rangoon.

LIST OF AGRICULTURAL PUBLICATIONS—*concld.*

No.	Title.	Author.	Where published.
	Economic Botany—contd.		
67	Bambuchu and how to contact it. Leaflet No. 5 in English and Canarese.	C. A. Barber, M.A., F.L.S.	Government Press, Madras
68	A Note on Concoanut Beetles. Leaflet No. 8 in English, Malayalam, Canarese, Tamil and Telugu.	Ditto.	Ditto.
69	Flora of the Upper Gangetic Plain and of the adjacent Siwalik and Sub Himalayan Tracts. Vol. II. Price Rs. 2 or 3 shillings.	J. F. Duthie, B.A., F.L.S., formerly Director of the Botanical Department of Northern India.	Government Printing, India, Calcutta.
	Entomology.		
70	Insecticides—Mixtures and Recipes for use against Insects in the Field, the Orchard, the Garden and the House. Bulletin No. 23 of the Agricultural Research Institute, Pusa. Price As. 12 or 1s. 2*d.*	H. Maxwell-Lefroy, M.A., F.E.S., F.Z.S., Imperial Entomologist.	Ditto.
71	The Swarming Paddy Caterpillar. Cultivator's Leaflet No. 25	Department of Agriculture, Burma.	Government Press, Burma, Rangoon.
72	The Lemon Butterfly. Cultivator's Leaflet No. 27	Ditto.	Ditto.
73	The Rice Grasshopper. (*Hieroglyphus banian, Fbr.*) Bulletin No. 1 of the Mysore Department of Agriculture. Price Re. 1.	L. C. Coleman, M.A., Ph. D., Mycologist and Entomologist to the Government of Mysore.	Government Press, Bangalore.
74	The Jola or Deccan Grasshopper (*Colemania Sphenarioides Bol.*) Bulletin No. 2 of the Department of Agriculture, Mysore. Price Re. 1.	Ditto.	Ditto.

PUBLICATIONS OF THE IMPERIAL DEPARTMENT OF AGRICULTURE IN INDIA.

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